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**A Comparative Analysis of the Public Transport Systems of  
Santiago de Chile, London, Berlin and Madrid: What can  
Santiago learn from the European Experiences?**

vorgelegt von

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## ABSTRACT

In 2001, 58 % of the motorised trips on a typical day were made by using public transport in Santiago, the capital of Chile. Comparing this with its proportion in 1991 (71 %) and 1977 (83 %) a clear decline in public transport use can be seen. The improvement of the public transport system is crucial to stop its decline in the modal split, and to accomplish a more sustainable urban transport system (together with complementary policies: for instance car parking restrictions, bicycle facilities). Based on positive experiences provided by three selected European metropolitan areas (Greater London, Berlin and Madrid) and taking into account theoretic and empirical evidence investigated by the author in previous studies and field trips, the aim of this research is to identify and analyse aspects in which the public transport system of Santiago de Chile can be improved. An important part of this research is the comparison and analysis of the socio-economic and transport data of the four metropolitan areas. During this analysis, two topics were identified and selected for further research: the institutional organisation of public transport (transport authority) and the fare structure of public transport.

In the case of the transport authority, the proposed solution for Santiago is the creation of a regional transport authority, responsible for the planning and implementation of both public and private transport policies, strategic plans and projects. It should also be responsible for the non-motorised modes and for urban planning and land-use definitions at the regional level. Responsibilities from other areas different to the transportation could also be transferred to the regional authority, as long as they have a regional scope. The regional government should change its appointment system, in the direction of directly elected head and representatives.

Travelcards allowing unlimited public transport use in a certain period (e.g. a month) may have a positive impact on public transport demand. Their implementation is recommended for Santiago. No technical problems for its introduction are detected, being the main difficulty an eventual unwillingness at the decision-making level. The relation between the fare and the trip-length is discussed. A mostly flat fare is recommended for Santiago. The differentiation of fares in peak and off-peak periods is also analysed. As shown in a numerical simulation, it is possible to increase both patronage and revenue through this measure. The average fare in Santiago is marginally lower than in Berlin and Madrid. Comparing it with the disposable income of the population, the public transport in Santiago is more expensive than in London, Madrid and Berlin. Unlike the European case study areas, the public transport system in Santiago does not receive operational subsidies. These kind of subsidies are fully justified by the economic theory in the case of urban public transport, and also represent a clear policy decision in the direction of giving incentives to the use of public transport. A subsidy in Santiago would be more likely, if it were not financed by fiscal expenditure but other sources (e.g. congestion charging). A regressive cross-subsidy from full-fare payers to the students should be eliminated, providing a compensation for the reduced students' fare.

During the time of this research the public transport system of Santiago was undergoing a major change under the name "*Transantiago*". All the analyses are made assuming that *Transantiago* is already implemented, i.e. the recommendations are centred in future improvement for the new system.

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# 1. Introduction

As many Latin-American countries, Chile presents a few large metropolitan areas where most of the population live. Public transport in these metropolitan areas is mostly privately owned, generally disordered and technically inefficient, but carries nearly all the urban trips. The private car has a smaller but growing importance in the transport system. Santiago, the capital of Chile, is a good example of this. In 2001, 58 % of the motorised trips on a typical day were made by using public transport. Comparing this with its proportion in 1991 (71 %) and 1977 (83 %) a clear decline in public transport use can be seen. The increase in the number of cars has led to more congestion and pollution. The improvement of the public transport system is crucial to stop the decline in the modal split, and to accomplish a more sustainable urban transport system.

In comparison with Santiago, public transport in many European metropolitan areas is much better organised. One aspect in which the typical Latin-American metropolitan area differs from the European one, is that in the latter there is always a local authority that plays an important role in the planning, control and sometimes, in the operation of the public transport system. Concerning the quality of the service, European buses carefully respect schedules and frequencies, and the accident risk is low. The typical Latin-American on-the-street competition is practically unknown in European bus systems, with the UK being the only exception. But even there it has changed significantly in the last years and the early irregularities have largely disappeared. My main question was: Is it possible to learn from the European experiences in order to improve the public transport system in a metropolitan area like Santiago?

The general aim of this research was the development of normative guidelines and recommendations for the improvement of the public transport system in Santiago. For that reason, the experiences in three large European capital cities have been studied. The selection of the European cases was made by searching for metropolitan areas with a population size similar to the one of Santiago. In addition, the metropolitan areas had to have an internationally recognised high-quality public transport system. Furthermore, the language skills of the author were taken into account in the election. Hence London, Berlin and Madrid were finally selected for the investigation.

The thesis is divided into two main parts. Firstly, chapters 2 to 6 present and compare socio-economic and transport data for the four researched metropolitan areas. During this work special attention was put on the identification of topics where lessons from the European experiences could be drawn in order to improve public transport in Santiago. Two of these issues were then selected for further analysis. They are presented in chapters 7 and 8: the institutional organisation of public transport (e.g. transport authority) and the fare structure of public transport.

During the time of this research the public transport system of Santiago was undergoing a major change (under the name "*Transantiago*"), which will modify the organisation of the bus system significantly (10 private companies would replace some 4,000 previous private operators), the routes design (main bus routes will complement the metro network, while local bus lines will feed both main bus lines and the metro) and the fare system (an integrated fare structure for buses and metro will be implemented together with a new

electronic payment device). Therefore, although *Transantiago* was not yet put into operation by the end of this investigation, all the analyses are made assuming that *Transantiago* is already implemented, i.e. the recommendations are centred in future improvement for the new *Transantiago* system. A good knowledge of that project, thanks to the fact that the author worked on its design at the Chilean transportation planning office (Sectra) before starting the Ph.D., was essential for the research. *Transantiago* is explained and analysed in detail in chapter 2.

The recommendations for the improvement of public transport in Santiago that have been developed are mainly based on the European experiences analysed, but they also take into account theoretic and empirical evidence investigated by the author in previous studies and field trips.

The focus of this research is on the improvement of public transport. Nevertheless, these improvements have to be complemented with other policies in order to accomplish a sustainable urban transport system. Congestion charging, car parking restrictions, pedestrianisations and bicycle facilities are some examples of other necessary measures.

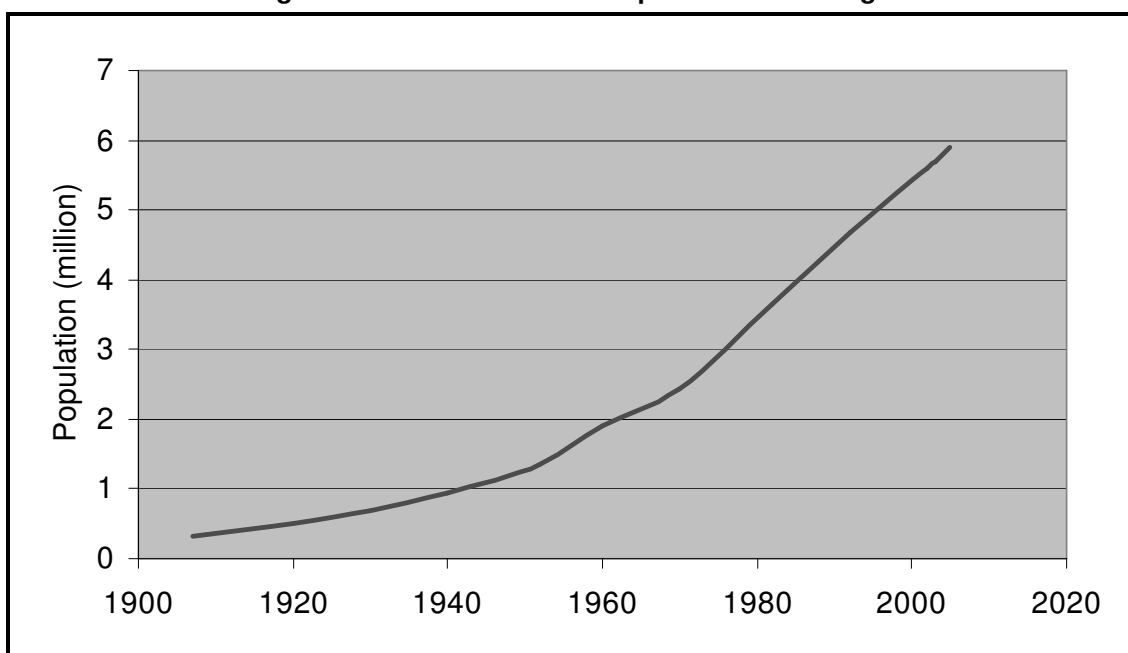
We will start by discussing the socio-economic aspects of Santiago de Chile and its transportation system.

## 2 Analysis of Santiago and its Transport System

### 2.1 Socio-economic Aspects

Santiago is the capital city of Chile. In 2005 the metropolitan area of *Gran Santiago* (Greater Santiago) had 5.9 million inhabitants while Chile as a whole had a population of 16.0 million. The evolution of the population in *Gran Santiago* is shown in figure 2.1. Having more than one third of the national population, Santiago is by far the largest city in the country. The second and third largest agglomerations have just 620,000 (Concepción-Talcahuano) and 586,000 (Valparaíso-Viña del Mar) inhabitants respectively. Santiago has an average population density of 6,900 people/km<sup>2</sup> in an area of 860 km<sup>2</sup>.

Figure 2.1: Evolution of the Population in Santiago



In economic terms, the importance of Santiago is even greater in the country, as 47 % of the Chilean gross domestic product (GDP) is generated there. The Chilean per capita annual GDP rose between 1984 and 2000 at an average yearly rate of 4.7 %, reaching US\$ 4,600 (€ 4,700) in 2000 (Casen, 2000). As shown in table 2.1, the income distribution is quite regressive: the income of the richest 20 % of the Chilean households is 15.3 times higher than the income of the poorest 20 %. The richest 20 % of the population receive 57.5 % of the total income. A better income distribution has been recognised in the last years by all political sectors as a key issue for the future development of the country.

**Table 2.1: Chilean Income Distribution in Year 2000**

Quintile <sup>(1)</sup>	Household income (US\$)	%
I	133	3.8
II	287	8.1
III	432	12.2
IV	650	18.4
V	2,029	57.5

<sup>(1)</sup> Each quintile is a fifth of the population. Quintile I represents the poorest 20 % of the population; quintile V represents the richest 20 % of the people.

Source: CASEN (2000)

The increase of income levels, along with a permanent rise of the city population, has yielded a very fast increase in the number of cars in Santiago in the last decades. Table 2.2 shows that between 1977 and 2001 the number of households increased 2.3 times whereas the number of cars quadruplicated.

**Table 2.2: Households, Cars and Motorisation Rate Evolution**

Year	Households	Vehicles	Vehicles/1.000 inhabitants
1977	650,000	208,000	60
1991	1,163,000	419,000	94
2001	1,514,000	855,000	148

Source: EOD (2001)

The increase in the motorisation rate is mainly explained by the growth in the income levels. The motorisation rate is still low in comparison with developed metropolitan areas as we will show later, and it will certainly continue rising in the next decades.

The city of Santiago is administratively divided into 38 municipalities. Each of them has a democratic elected Mayor. No single political authority responsible for the entire city exists. Table 2.3 shows the population and the motorisation rate of the different municipalities in 2001. The municipality of *Santiago Centro* corresponds to the historical centre of the city accounting for less than 4% of the population of the metropolitan area. It can be seen that the motorisation rate is very heterogeneous among the municipalities. The highest motorisation rate is 429.2 cars per 1,000 inhabitants in Vitacura, while the lowest is only 52.0 cars per 1,000 inhabitants in La Pintana. This is due to an unequal income distribution among the municipalities explained by the localisation of the high-income families mainly in the eastern municipalities, as can be seen below.

The municipalities of Santiago are usually grouped into six areas (figure 2.2) as follows:

- **North:** Conchalí, Independencia, Huechuraba, Quilicura, Recoleta, Renca, Colina and Lampa.
- **East:** La Reina, Las Condes, Lo Barnechea, Ñuñoa, Providencia and Vitacura.
- **South-East:** La Florida, Macul, Peñalolén, Puente Alto and Pirque.
- **South:** El Bosque, La Cisterna, La Granja, La Pintana, Lo Espejo, Pedro Aguirre Cerda, San Bernardo, San Joaquín, San Miguel, San Ramón and Calera de Tango.
- **West:** Cerrillos, Cerro Navia, Estación Central, Lo Prado, Maipú, Pudahuel and Quinta Normal.
- **Centre:** Santiago Centro

**Table 2.3: Population and Motorisation Rate per Municipality in Santiago**

<b>Municipality</b>	<b>Population</b>	<b>Vehicles/1,000 inhab</b>
Calera de Tango	18,392	147.4
Cerrillos	72,703	120.7
Cerro Navia	143,791	87.4
Colina	81,230	98.6
Conchalí	132,226	108.8
El Bosque	181,971	101.4
Estación Central	125,499	119.6
Huechuraba	68,321	107.9
Independencia	71,184	143.3
La Cisterna	83,896	135.2
La Florida	381,515	159.2
La Granja	126,767	78.3
La Pintana	185,069	52.0
La Reina	104,703	321.7
Lampa	46,924	109.2
Las Condes	279,204	378.0
Lo Barnechea	92,725	306.9
Lo Espejo	115,913	68.4
Lo Prado	107,372	91.8
Macul	113,575	184.9
Maipú	488,939	151.0
Ñuñoa	176,969	232.5
Pedro Aguirre Cerda	104,649	81.6
Peñalolén	211,239	152.6
Pirque	19,871	164.8
Providencia	139,395	310.3
Pudahuel	201,098	99.9
Puente Alto	557,880	102.0
Quilicura	138,541	127.7
Quinta Normal	101,412	116.3
Recoleta	149,934	104.0
Renca	134,401	93.8
San Bernardo	232,435	91.7
San Joaquín	98,166	106.3
San Miguel	80,006	189.0
San Ramón	90,562	69.4
Santiago Centro	230,674	123.2
Vitacura	83,466	429.2
<b>TOTAL</b>	<b>5,772,617</b>	<b>148.1</b>

Source: EOD (2001)

Figure 2.2: Santiago in Six Areas

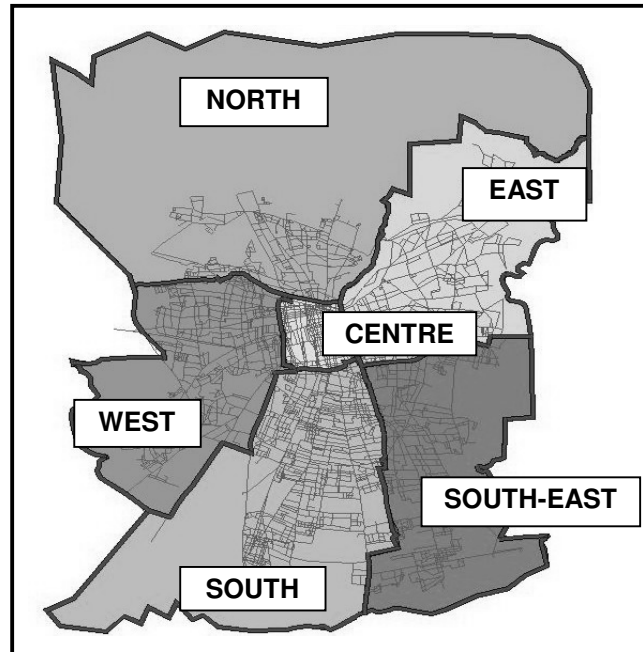


Table 2.4 shows the population, the average household income and the motorisation rate in each one of these six areas. It can be clearly seen that the richest families live in the East Area, and that it is there where the highest motorisation rate exists. The Centre Area has the second highest income level and the third highest motorisation rate, but both are far below the income and motorisation rate of the East Area. The lowest income is in the South Area, which also has the lowest motorisation rate.

Table 2.4: Income and Motorisation Rate per Area in 2001

Area	Population	Household income (US\$/month)	Vehicles/1,000 inhabitants
North	822,761	114	110.6
East	876,462	607	328.5
South-East	1,284,080	147	135.6
South	1,317,826	109	92.3
West	1,240,814	120	122.4
Centre	230,674	190	123.2

Source: EOD (2001)

## 2.2 Modal Split Changes

According to the last Origin-Destination Survey (EOD, 2001), on a typical workday 16.3 million trips are made in Santiago. From those 10.0 million are motorised and 6.3 million are non-motorised trips (walking, cycling). The methodology of this survey considers that a trip is every movement made in the public space independent of its length. This is why there is such a high proportion of non-motorised trips. As usual, a trip is defined as a change in activities and may therefore contain transfers. For example, a trip that is made partly by bus and partly by metro (two stages) is only counted once.



In table 2.5 the modal split for a typical working day in Santiago in 2001 is presented. The main motorised modes are bus and car, which are much more used than taxi, shared-taxi and the metro. Shared-taxis exist in Santiago and other Chilean cities, being even the main public transport mode in some medium-size cities. Shared-taxis consist of cars that run on specific routes at fixed intervals. I.e. a shared-taxi route is very similar to a bus route, but with smaller vehicles. As one of the seats of the shared-taxi is occupied by the driver, there are only 4 seats available for passengers.

**Table 2.5: Modal Split Working Day in Santiago in 2001**

Transport mode	Trips (thousand)	%
Car	3,860.0	23.7
Bus	4,220.9	25.9
Taxi	206.8	1.3
Shared-Taxi	398.2	2.4
Metro	370.8	2.3
Car – Metro	29.6	0.2
Bus – Metro	177.9	1.1
Shared-Taxi - Metro	68.4	0.4
Taxi – Metro	10.2	0.1
Others – Metro	17.7	0.1
Walking	5,978.4	36.7
School Bus	406.9	2.5
Bicycle	303.9	1.9
Others	234.3	1.4
<b>TOTAL</b>	<b>16,284.0</b>	<b>100.0</b>

Source: EOD (2001)

Combined modes (e.g. car – metro) have little importance when compared with the main pure modes. Therefore, the modal split is shown again in table 2.6 aggregating the data into six main modes, and both for a complete workday and its morning peak (between 7:30 and 8:30 when 1,880,000 trips are made).

**Table 2.6: Modal Split Working Day and Morning Peak in Santiago in 2001**

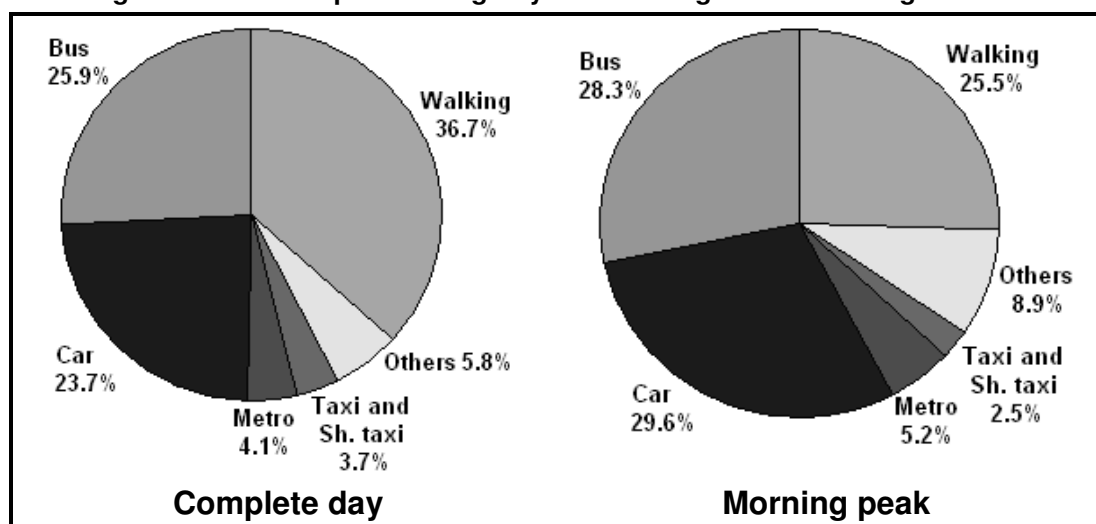
Transport mode	Modal split complete day		Modal split morning peak	
	Trips (thousand)	%	Trips (thousand)	%
Walking	5,978.4	36.7	479.4	25.5
Others	945.1	5.8	167.3	8.9
Taxi and Sh.Tx.	605.0	3.7	47.0	2.5
Metro	674.6	4.1	97.8	5.2
Car	3,860.0	23.7	556.5	29.6
Bus	4,220.9	25.9	532.0	28.3
<b>TOTAL</b>	<b>16,284.0</b>	<b>100.0</b>	<b>1,880.0</b>	<b>100.0</b>

Source: EOD (2001)

Figure 2.3 shows the information of table 2.6 in graphs. It can be seen that most of the motorised modes increase their modal split in the morning peak, compared with the modal split of the complete day. This is particularly important in the case of the car. On the contrary,

the modal split of the walking trips (which are usually undercounted) is lower in the morning peak than during the complete day. It also shows the relatively small share of metro trips.

**Figure 2.3: Modal Split Working Day and Morning Peak in Santiago in 2001**



The increase in the income levels and motorisation rate, along with the bad quality of the bus system, yielded an important decrease in the public transport modal split during the last decades. Moreover, the car use has augmented and congestion has increased steadily. Considering only the motorised trips<sup>1</sup>, table 2.7 shows the strong decline of the public transport modal split.

**Table 2.7: Evolution of the Modal Split**

Year	Public transport (%)	Private transport (%)	Others (%)
1977	83.4	11.6	5.0
1991	70.5	19.7	9.8
2001	51.9	39.2	8.9

Source: EOD (2001)

It has to be said that this relative decline in the public transport modal split does not imply an absolute decline in the number of public transport trips. In fact, as the population of the city and the number of trips per person have increased, the absolute number of public transport trips has increased as well. But the absolute number of car trips has augmented much more rapidly.

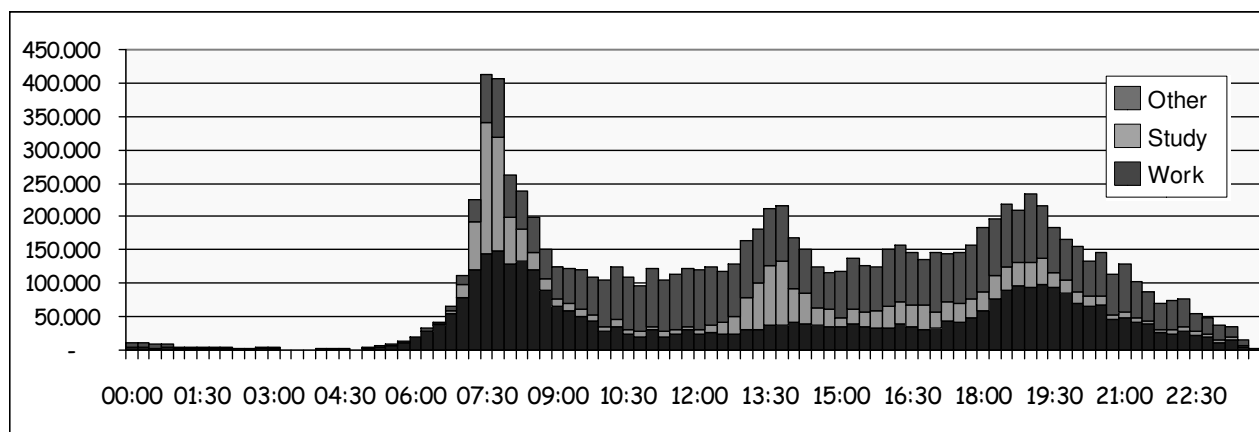
## 2.3 Other Characteristics of the Trips

Figure 2.4 shows a histogram of motorised trips divided by trip-purpose for the year 2001. The histogram is divided into 15-minute intervals. Three peak periods can be recognised.

<sup>1</sup> In the last Origin-Destination Survey there was a methodological change that makes it impossible to compare the non-motorised trips with those in the previous surveys.

The morning peak is much higher than the midday and afternoon peaks. The purpose “other” (shopping, health, social, etc.) dominates in the complete day figures (table 2.8), but in the morning peak, the work and study trips are the most important ones. There is a strong concentration of study trips in just half an hour in the morning. Efforts are being made to change the time at which some schools begin, in order to reduce the number of study-trips during the morning peak. It is worth noting that during the last years the motorised trips with the purpose “other” have strongly increased due to the growth in the income levels.

**Figure 2.4: Motorised Trips by Purpose on a Weekday in 2001**



Source: EOD (2001)

**Table 2.8: Motorised Trips Purpose, Year 2001**

Purpose	Morning peak (%)	Complete day (%)
Other	21.0	44.6
Study	36.0	19.1
Work	43.0	36.3

Source: EOD (2001)

Table 2.9 shows how the number of motorised trips per person has changed in the last decades. The motorised trips generation rate doubled between 1977 and 2001.

**Table 2.9: Evolution of the Motorised Trips Generation Rate**

Year	Motorised daily trips per person
1977	0.87
1991	1.29
2001	1.74

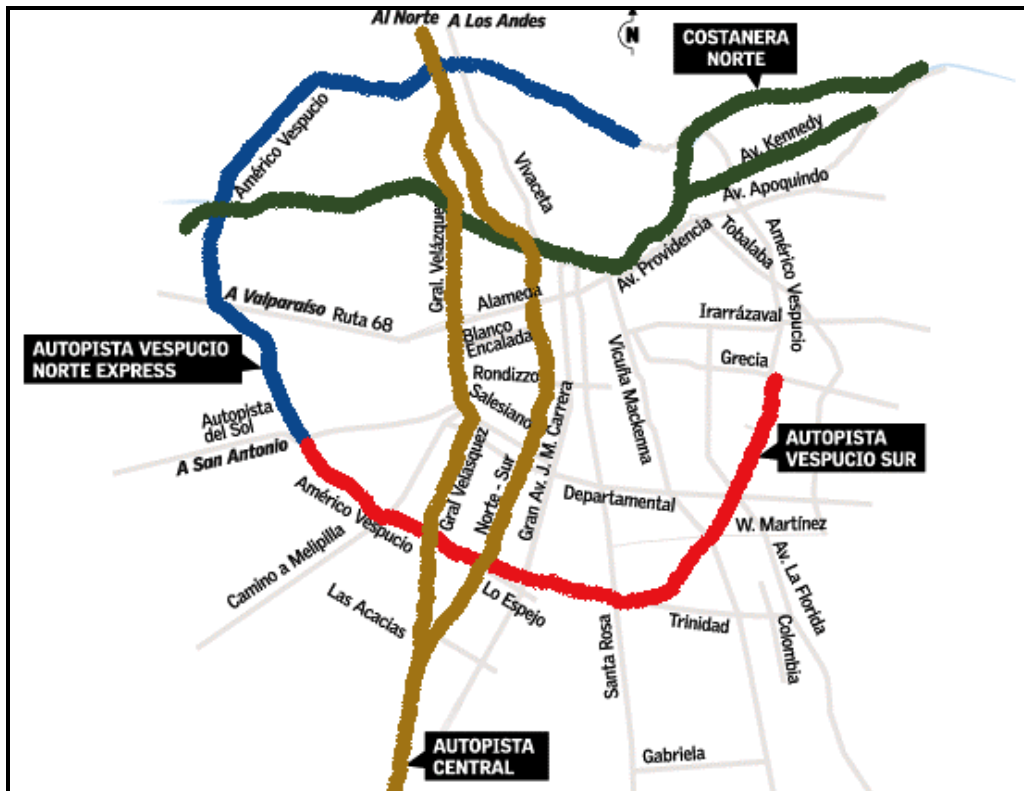
Source: EOD (2001)

It can be seen that the mobility in Santiago is changing. Some of the more evident modifications are that the people have more cars and make a higher proportion of trips in them, and that the people are making more trips in general. The increase in income is probably the main reason that explains this change, combined with a bad-quality bus system.

## 2.4 Private car: large investment in urban highways by the beginning of the 2000s

Although the declared urban transport policy of the last governments in Chile had been to promote the use of public transport and rationalise the use of cars, between 2001 and 2006 a total of 150 km of urban highways were constructed in Santiago (figure 2.5), with a total investment of US\$ 2,000 million. This is by far the most important development of new road infrastructure in the history of Santiago.

Figure 2.5: New Urban Highways in Santiago



The north-south connection (*Autopista Central*) and the ring highway (*Autopista Vespucio Norte Express* and *Autopista Vespucio Sur*) correspond to major improvements of existing roads, in order to achieve highway standards on them. In contrast, the east-west highway (*Costanera Norte*) that connects the high-income east with the centre and the west (close to the international airport of Santiago) is a completely new highway. It runs partly on the north side of the main river of Santiago (*Mapocho River*) and partly in a tunnel under it.

All these highways are being constructed and partially financed by the private sector. Their construction and operation over a period of 30 years was tendered to private companies, which will receive revenues from tolls that the users will have to pay. The tolls will be paid electronically so that the cars do not need to stop at the toll points.

This concession system has been used previously in interurban highways in Chile, and is similar to the one used in Madrid for the construction of the metro extension Line 9 and the intermodal transfer station *Avenida de América* (Cristóbal-Pinto, 2003).

## 2.5 Metro, the Pride of Santiago's Public Transport System (and Other Rail Services)

In 2003 Santiago had 3 **metro** lines (figure 2.6) with a total length of 40 km and 52 stations. The average distance between stations is 800 metres. Most of the network (69 %) is underground whereas 16 % runs on surface and 15 % is elevated. All the trains roll on pneumatic wheels (French technology) and the operation is automatic. Nevertheless, all the trains have a driver and they can also be driven manually. The average commercial speed in the entire network is 32 km/h (Metro de Santiago, 2003b pp3-4).

Figure 2.6: Metro Network in 2003

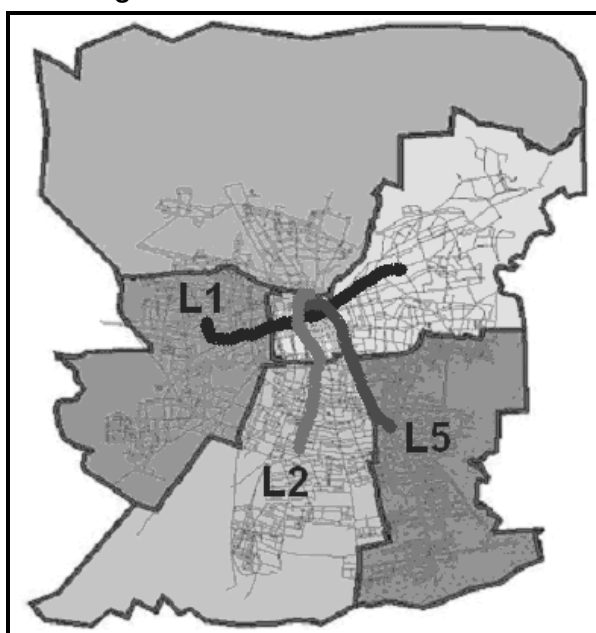
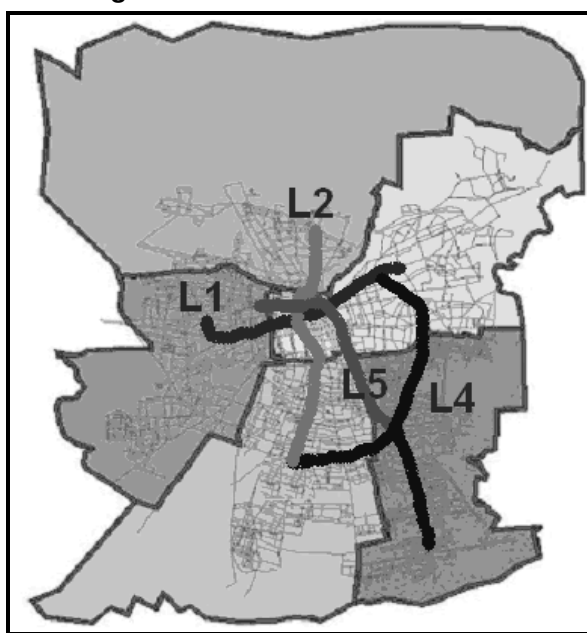


Figure 2.7: Metro Network in 2006



Note: Line 3 has not yet been constructed.

In 2005 the metro had 133 trains with a total of 636 vehicles (Metro de Santiago, 2005). The evolution of the demand and supply is presented in table 2.10. The yearly patronage of the metro has been continuously growing along with the network expansion, reaching 267 million passengers in 2005. The number of vehicle-kilometres reached 51 million in 2005.

Table 2.10: Evolution of the Metro Demand and Supply

Year	Passengers (million)	Network (km)	Veh-km (million)
1979	94	21.1	16
1984	111	25.6	19
1989	153	27.3	20
1994	167	27.3	23
1999	185	37.6	34
2003	203	40.3	41
2005	267	67.3	51

Sources: Metro de Santiago (2003b p4, p6, p28; 2005)

The first metro line opened in Santiago in 1975 with a length of 8.2 km. The metro is operated by a public owned company (Metro S.A.), which does not receive operational subsidies. This implies that the fare revenues and other secondary revenues (e.g.

advertisement) have to cover all the operational costs. In 2003, fare revenues accounted for 90 % of the operational incomes whereas advertisement, shop rental rents and other incomes represented 5 %, 3 % and 2 % respectively (Metro de Santiago, 2003a pp35-37). The total operational income in 2003 was 60,143 million Chilean pesos, i.e. € 77 million, while the cost of the operation was € 75 million (Metro de Santiago, 2003c p51).

Frequencies are generally high. In the peak hour the interval is lower than two minutes on the east-west line number 1. The metro system is perceived as a very quick, comfortable, reliable and clean mode. It is used by people of all income groups and it has a very strong company image. Nevertheless, the modal split was relatively low in 2001, as shown in table 2.6. This is explained by the short length of the system (only 40 km in a metropolitan area of 5.4 million inhabitants), as can be seen in figure 2.6, and by the competition that it had by buses. In fact, there were many bus lines that ran parallel to the metro lines. As passengers would have had to pay a double fare to transfer from a bus to the metro, there were many users who stayed on the bus, in spite of its worse perceived service level.

42 new kilometres were added to the metro network between 2004 and 2006 (figure 2.7). The new infrastructure, including a new line (L4), had an investment cost of US\$ 1,400 million. As was the case with the urban highways, this is the most important extension of the metro since it was inaugurated in 1975. In fact, the network was more than doubled with these new 42 km. The cost of these extensions is financed by the Chilean State, but for the first time part of the infrastructure cost will be paid by Metro S.A., i.e. by the metro users.

In addition, there is an **urban rail** service in Santiago (*Metrotren*) running only one line along the main long-distance rail track that connects Santiago with the cities of the central-south of the country (Temuco, Chillán, etc.). *Metrotren* is operated by the state owned *Empresa de Ferrocarriles del Estado* (EFE). The main cities that are connected with Santiago by the *Metrotren* (Rancagua and San Fernando) are 87 and 142 km away from the capital, implying that *Metrotren* provides an interurban service. Nevertheless, there are five stations inside Santiago, which are mainly used for urban trips. Although these urban trips represent only 0.1 % of the public transport trips in Santiago, the use of *Metrotren* has shown an impressive growth after its creation in 1990. The urban and interurban patronage of *Metrotren* rose from 1.9 million passengers in 1994 to 7.6 million trips in 2004. The supply grew from 22 departures in 1994 to 94 departures in 2005 (EFE, 2005).

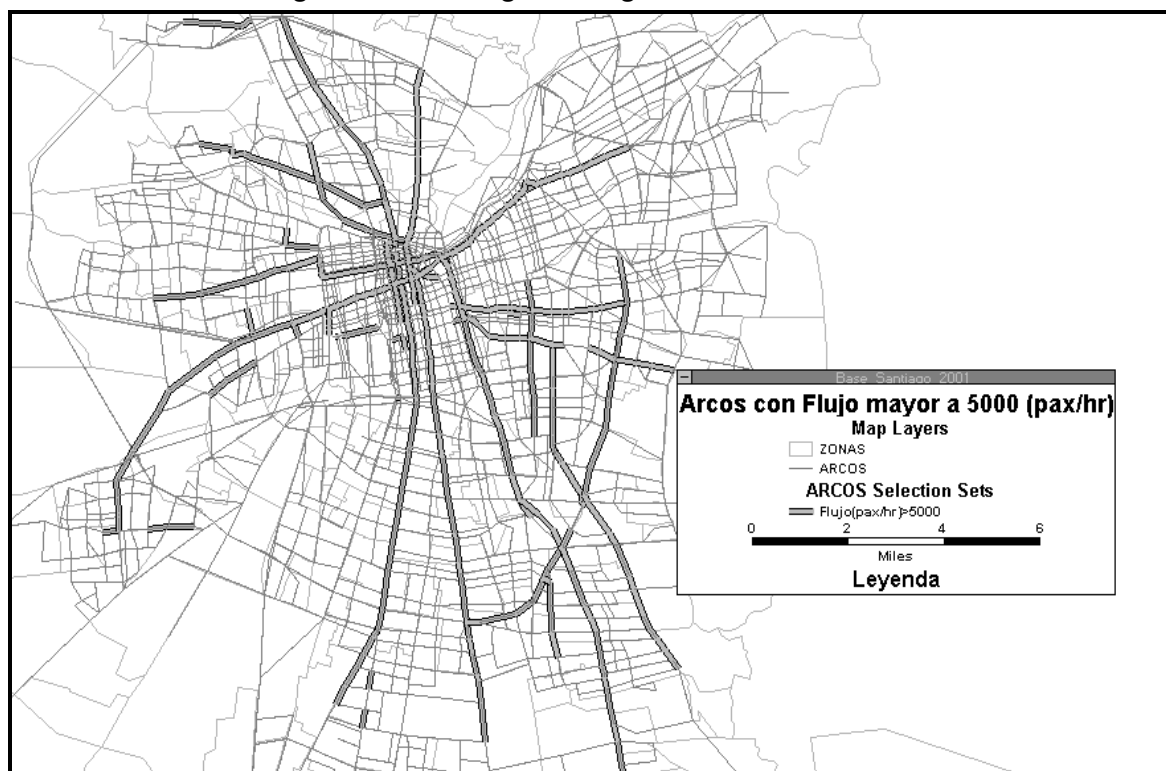
## 2.6 Buses: on-the-Street Competition and Bad Service

In 2005 there were 380 bus lines in Santiago with an average length of 60 km (adding both directions). The network is presented in figure 2.8. One can see a wide spatial coverage and many lines overlapping in some parts of their routes. Hence it is possible to travel without transfer between many origin-destination points. Therefore, the average number of transfers per trip was only 0.1 for bus trips and less than 0.2 for trips using bus and/or metro. This very low value was also explained by the absence of integrated fares. Transfers implied that a new fare had to be paid making them very expensive.

**Figure 2.8: Bus Lines in 2003**

The high demands and the overlapping of routes produced very high frequencies in many streets. In the main street of Santiago (*Alameda*), there were more than 600 buses per hour per direction in 2001 close to the central rail station (Sectra, 2001). Regarding the high bus demands, figure 2.9 shows the streets where there were more than 5,000 passengers per hour in one direction in the morning peak in 2001. The highest bus demand was again in *Alameda* close to the central rail station, where more than 30,000 passengers per hour travel in the morning peak in west-east direction (Sectra, 2001). It is interesting to note that the highest metro demand was found in the line that runs exactly under *Alameda* and practically in the same point and direction. Thus another 30,000 passengers per hour were travelling by the metro in the morning peak. Altogether the impressive amount of 60,000 public transport passengers per hour in one direction was counted. In one year 1,200 million bus trips were made (2001).



**Figure 2.9: Morning Peak High Demand Bus Streets**

Source: Sectra (2001)

There were around 8,000 buses in Santiago in 2005, all of them privately owned and operated by approximately 4,000 “companies”. In fact, circa 2,500 bus owners had just one bus, and another 1,000 owned 2 or 3 vehicles. There were only 3 companies with more than 50 buses (Sectra, 2003). The fare, which was directly collected by the bus driver, had to cover all the operational costs, as the operators did not receive any subsidy. Trying to maximise the number of passengers carried in each bus, each operator paid part of the fares collected to the driver. Therefore, the driver’s wage was proportional to the number of passengers he carried. If the driver wanted to earn more money, he had to compete with all the other buses to catch as many passengers as possible.

Although there were different models of buses in 2004, they were very homogeneous in terms of size and capacity. The typical bus was 10 to 12 meters long with a capacity of 60 to 80 passengers, half of them seated. There were no low-floor vehicles and it was practically impossible to board them in a wheelchair or with a baby carriage. There were some smaller vehicles (40 passengers), mainly on the lines that operated in agreement with Metro S.A. as feeder routes with an integrated fare.

Bus lanes are generally not respected by car drivers in Santiago. Therefore, some effort has been made in order to build physically segregated bus roads. Nevertheless, in 2004 there was only a partial physical segregation in the main road of Santiago (*Alameda*) and a fully segregated bus road of just 4 km in a secondary street (*Avenida Grecia*).

An interesting and brave effort in order to improve the circulation of the buses was made in 2001 when 82 km of the main streets of Santiago were declared bus-only roads in the morning peak period. There was a big concern in the public opinion about the congestion problems that this measure might produce in other streets of the metropolitan area. All the discussions before the implementation of this measure about its negative effects helped to



inform the public about it. So the people were able to decide in advance if they wanted to change their travel behaviour, and many of them did so. In fact, traffic counts revealed that many car drivers changed their travel times (they travelled earlier before the bus-only period, alleviating the peak period), and public transport increased its patronage. Therefore, no important worse conditions were seen on alternative streets. This result is consistent with experiences in many other metropolitan areas in the world where road capacity reductions were carried out, as reported by Cairns et al. (1998).

As these bus-only streets are an administrative measure, they can easily be revoked. Therefore, it is impossible to be sure if this bus priority measure will remain in the future. In 2004, general traffic was already allowed in some of the original bus-only streets, with the aim of alleviating the traffic impact of the closure of major streets that were affected by the construction of the new highways or the metro extensions.

An ambitious plan to improve the bus system in Santiago started its implementation in 2005 and is scheduled to be completed by the beginning of 2007. A detailed description of this system, called Transantiago, is presented below.

## 2.7 Shared-Taxis: Cars Offering Bus-like Services

The shared-taxi is a public transport mode that uses cars running on specific routes with regular intervals. The services are similar to a typical bus service, but with smaller vehicles (cars). Mainly, there were two types of shared-taxi services in Santiago in 2003. The first was a long-distance service that linked the centre of Santiago with the periphery. These services were more expensive than buses or metro, but they were faster. In addition, they could slightly change their routes in order to get closer to a passenger's destination if he asked for (and sometimes also paid a little extra). The second type was feeder services to metro stations or local centres in peripheral zones. Shared-taxis' fares were not integrated with other public transport modes. They were privately owned and did not receive operational subsidies.

As can be seen in table 2.5, the modal split of the shared-taxi was small in comparison with car or bus. At the same, it was comparable to the modal split of metro. In fact, in some peripheral municipalities (e.g. *Puente Alto* and *Maipú*) the shared-taxi played a very important role in the local trips. A total of some 200 million trips was made in shared-taxis in 2001.

The shared-taxi industry was still deregulated in terms of fares and route design in 2003. This produced a big increase in their services, especially feeder routes that compete with buses for that demand segment. Many of these vehicles were only used as shared-taxis in the peak periods, being used as normal taxis in the off-peak. In 2003 the total fleet of taxis and shared-taxis was fixed, in order to avoid a further increase of it. Nevertheless, there was still the possibility of transforming normal taxis into shared-taxis.

An attempt to introduce regulations in the shared-taxi industry is being made with a route tendering process that began at the end of 2003. The longer routes that linked the periphery of the metropolitan area with the centre were eliminated, and only shorter feeder or local routes should remain.

## 2.8 Critical Analysis of *Transantiago*, the New Bus System in Santiago

Prior to 1975, bus lines, frequencies and fares were defined by the authority. The operators were not allowed to introduce changes and the bus system was highly inflexible (Transantiago, 2005a). Afterwards, a process of deregulation began in the industry.

By 1980 the bus system was completely deregulated in terms of fares, frequencies and route design. The entrance to the industry needed the authorisation of the Transport Ministry, but an incorporation application was never denied, except for formal reasons. In 1988 even the need for this authorisation was eliminated, and therefore any bus passing a mechanical test could operate without any restriction on fares or routes (Fernández, 1994).

Fares grew constantly in real terms and this was accompanied by increases in the vehicle fleet, which in turn made the fares rise again and so on. Between 1979 and 1989 the bus fleet doubled and the fare more than doubled in real terms. Small buses were mostly used and high levels of congestion, pollution and accidents were observed. On the other hand, route density and frequencies increased, reducing walking and waiting times (Fernández, 1994). There was no actual competition in fares or service quality because after the government stopped regulating the industry, a cartel of operators took over the control of the activity (Darbera, 1993; Fernández, 1994). The only competition was on the streets, with buses fighting to catch the next passenger.

At the beginning of the 1990s a big effort was made to move competition from the streets of Santiago to a competitive tendering process. Only the routes that crossed the centre were tendered, i.e. the routes with higher demands. This broke the operators' cartel and they actually competed in the tendering process that granted operation concessions for three years. But in the next process almost all routes were tendered. In addition, some conditions of the tender only allowed current operators to participate in the tendering. Because of these facts, the operators could act as a cartel again, agreeing in advance on a distribution of the routes among them and avoiding a real competition in the tender<sup>2</sup>.

This new system had some success in diminishing the excessive number of buses, reducing the fares and improving the technical conditions of the vehicles. Nevertheless, those lines with small operators (owning a few vehicles each) did never act as a real company. On the contrary, each bus owner managed his own income, independent of the revenues of the other buses. So, competition in the streets remained reality even among vehicles of the same line. Because of this, uncertainty in waiting and travel times and high levels of accident risk did not disappear.

On the other hand, the authorities did not increase their role in the planning of the bus system. Only small changes in the route designs were made during the 1990s, and those were propositions of the operators, which were normally accepted by the authority. The fares were regulated, but the authority could not change them at will. Initial fares were determined in the tendering process, and afterwards they changed according to a mathematical equation established in the contracts that reflected the variations in the operation costs.

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<sup>2</sup> In the last tender 97 % of the operators asked for the maximal fare allowed and 76 % presented an offer for only one route, although offers for up to two routes were permitted (Sectra, 2003).

### **Diagnosis of the bus system by the early 2000s**

At the beginning of the 2000s, the bus system still presented important problems that produced a very bad perception of bus services by the population. Surveys comparing the satisfaction of the people with different public services (water, electricity, supermarkets, etc.) always showed public transport at the last places. So the bus system was mainly used by those who did not have an alternative. As the motorisation rate increased, a higher proportion of the people could switch to the car, explaining the drastic drop in the public transport modal split in the last decades (see table 2.5).

The **main negative characteristics** of the bus system are listed and explained here:

1. **Waiting times were unpredictable** and sometimes high because buses competed on-the-street not only with other lines, but also with other vehicles from the same line. It was normal to see two or even three buses from the same line travelling together, “fighting” to catch the passengers at the next stop. This form of operation intensified bus bunching, increasing headways and waiting times. And even worse, a passenger waiting at a low-demand stop could undergo the highly frustrating experience of seeing how one or more buses he would like to board do not stop, because they are trying to arrive first at a following high-demand stop.
2. This form of competition, together with drivers who are working too many hours a day, implied a **high accident risk** as well as stressed and often aggressive **drivers who were anything but friendly to the users**.
3. Moreover, this aggressive form of driving increased the **noise and pollutant emissions** of the system. On the other hand, both an excess of buses running in the off-peak periods and the overlapping (competition) of bus lines and metro increased the perception that the bus system was highly pollutant. Nevertheless, strict emission norms were introduced in the 1990s and at the beginning of the 2000s almost all the vehicles fulfilled the emission norm Euro II, while new buses had to fulfil Euro III.
4. **Lack of cleaning and preventive maintenance**: Buses were not cleaned enough and they deteriorated quickly, as not-critical damages were not repaired soon (graffiti, damaged seats, dents, etc.). Moreover, only the few bigger companies did preventive maintenance, while the small operators used their buses until something broke. And when this happened, the vehicle had to be fixed as soon as possible, because having their vehicles in the garage for maintenance was perceived as a direct loss of revenue (as their only income was the fares directly paid in the bus). Nevertheless, after the tendering of the 1990s, buses could not exceed a maximal age of 10 or 12 years, so that new vehicles were continuously entering the fleet.
5. Although not directly perceived by the users, **inefficiencies in the route and frequency design** had an impact on the fares. Firstly, every bus line was designed over the years with the aim of maximising the number of passengers on that route. Secondly, given that every bus generated income only when it was running on the street, no operator was willing to let it in the garage in the low-demand periods. All this implied an excess of veh-km that had to be paid for by the fares.
6. Almost no **users’ information** was available.

On the other hand, there were the following **positive aspects** for the bus users:

1. Though unstable, frequencies were high (some 8 buses per line per hour on average) not only in peak periods, but also during off-peaks and at weekends. Moreover, as many lines overlapped, passengers could use different lines and had therefore very **low waiting times**. In addition, there was a **high probability of getting a seat** during off-peak periods and at weekends.
2. There was a high density of routes, yielding **low access (walking) times**.
3. As bus lines were long and many of them overlapped, **it was possible to travel between many origins and destinations in a direct route**, i.e. without a transfer.

In spite of their impact on the operation costs, the operators always maintained the following two characteristics:

- The **driver's wage was directly dependent on the number of passengers** he caught. The resulting on-the-street competition implied higher operation and maintenance costs.
- **All buses were in operation in the off-peak periods**, yielding higher operation costs than if some buses would have been run only in the peak periods.

Why did the operators have such a strange behaviour, operating in a form that implied higher costs for them? Two aspects of the system have to be kept in mind to understand this paradox. First, there were more than 4,000 operators and the majority of the buses belonged to an operator that owned less than 4 buses. And second, lines overlapped in extended sections of their routes so that many passengers could travel indistinctly in different lines. This means that the potential demand (and income) was shared among distinct lines.

If one operator had decided to pay a fixed salary to his drivers, his vehicles would have transported fewer passengers, because of the on-the-street competition of other buses. His income would have fallen. If he had decided to let some of his buses rest in off-peak periods, again he would have lost some passengers that would have been transported by other operators. It has to be taken into account that the marginal cost of running a bus in the off-peak was quite low: according to the cost estimations made by Sectra (2003), if a bus ran an additional cycle of 60 km, the consume of fuel, lubricants, tyres, the payment of the driver, etc., could be recovered with just 50 passengers boarding the vehicle, i.e. less than one passenger boarding per kilometre. Therefore, running a cycle in the off-peak normally produced a profit, even with a very low occupancy of the bus.

The cartel did not have power enough to reach an agreement among all the 4,000 operators in order to change the salary policy or the off-peak operation frequencies. In fact, if such a change had been agreed, the system would have been in an unstable equilibrium, as every operator would have had an economic incentive to change back to the previous behaviour. On the contrary, the observed behaviour was a stable equilibrium, because no operator had an incentive to change his form of operation. The only way in which lower frequencies in off-peak periods could actually be implemented was through a number plate based running restriction that the authority implemented with the aim of diminishing the pollutant emissions of the industry.

On the other hand, a similar analysis can be made to explain the absence of express services and shorter lines. These would have reduced the total operation cost of the system, but every operator perceived that making a change in those directions would have reduced his potential demand and earnings.

On the whole, the existence of too many operators sharing the demand was one of the key aspects of the problem, yielding incorrect economic incentives for operators and drivers. In addition, a coordinated design of routes and frequencies was needed! It is interesting to note that the problems of the public transport system of Santiago were similar to the problems of many other Latin-American metropolitan areas.

### **The strategy behind the new plan**

A substantial change was needed in the bus system of Santiago if the decline in the public transport modal split was to be stopped. The following strategic points were considered in the design of the final plan:

- The participation of the authority in the planning and regulation of the system had to be increased, but keeping the operation in the private sector.
- The improvements had to encompass the entire bus system, not just a part of it (e.g. selected corridors).
- A new route and frequency design had to be introduced, coordinating the bus lines not only among each other, but also with the metro.
- An integrated fare system encompassing both buses and metro also needed to be implemented.
- The property structure of the industry needed to be changed, from thousands of bus owners with a few vehicles each to several larger bus companies.
- The economic incentives perceived by the operators had to be corrected, in order to eliminate the on-the-street competition and reach a higher quality in the service.
- The positive characteristics of the previous system should be maintained: high frequencies, high route density and low level of transfers.
- The fares had to be kept at similar levels, without operational subsidy. Though economic justifications for subsidising the public transport were known (Jara-Díaz and Gschwender, 2005), the absence of any operational subsidy was an active political restriction.
- Any change in the laws should be avoided, in order to reduce the risk of delays due to political discussions. Two already existing laws could be used: firstly, a law allowing to regulate the operation of the transport system when high congestion, pollution or accident levels existed (which was created for the tendering processes of the 1990s), and secondly, a law that allowed the concession of infrastructure investment to the private sector.
- Intensive requirements of new infrastructure should not be a key aspect of the plan, in order to allow it to be implemented even in the absence of funds for the construction of new infrastructure.

## **Main aspects of the proposed new system**

### **1. A public transport authority and private companies**

Following successful experiences in other Latin-American metropolitan areas (e.g. Bogotá), the creation of a public transport authority that contracts private companies to operate the buses, tickets selling and income management was proposed. This transport authority should be responsible for the coordination of services and fares. The final design also incorporated the externalisation of the information management. So, the authority tendered to the private sector the following three concessions:

1. The **operation of the buses**, which are run by different private companies: this issue will be explained more in detail later. Following the public transport organisation models defined by Costa (1996), this corresponds to the “authority and multiple operators” model, which is also used in some European metropolitan areas as London and Copenhagen (see Haubitz 2004 for the latter).
2. A **finance administrator** (*Administrador Financiero de Transantiago*, AFT): the main tasks of this concessionary are
  - a) the selling and charging of a contactless smartcard that will become the main payment form in buses and the metro,
  - b) the administration of the revenues and payment to the bus operators, metro and other agents, according to the payment conditions established in the different contracts and the instructions of the authority regarding penalties and rewards and
  - c) providing, installing and maintaining ticket-reading machines for the buses.
3. An **information manager and users’ information provider** (*Servicios de Información y Atención a Usuarios de Transantiago*, SIAUT): the main tasks of this concessionary are
  - a) the collection, storing and distribution of operational information from the buses (GPS position, etc.),
  - b) processing the operational information and producing reports for the authority, in order to supervise the fulfilment of the contracts and determine penalties and rewards and
  - c) provide users’ information.

The payment to the AFT will be a fixed amount plus a percentage of the users’ fares. The SIAUT will receive a fixed payment.

### **2. New bus routes structure and operators’ payment system**

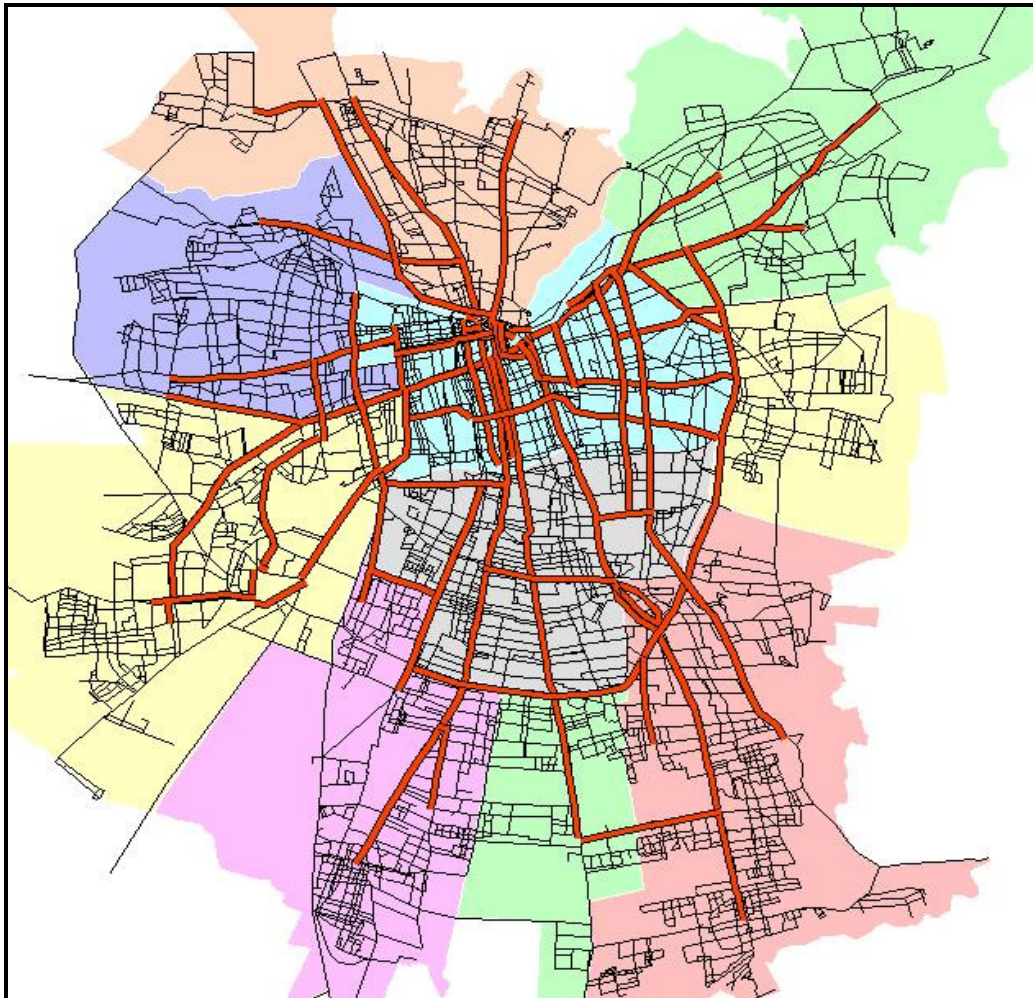
A new design for bus routes, frequencies and vehicle sizes, along with a new bus operators’ payment system was proposed, with the aim of eliminating the on-the-street competition and avoiding excess of offer due to competition both among bus lines and between bus and metro lines.

The routes scheme proposed included three complementary public transport networks:

- The metro lines.
- A network of main bus routes.
- A network of local and feeder bus lines, organised in separate areas.

Figure 2.10 shows an example of the main bus routes network (dark lines) and the local areas (in different colours). Local bus lines and metro lines are not shown in the figure.

**Figure 2.10: Example of the Main Buses Network and Local Areas**



Source: Sectra (Chilean Transportation Planning Office)

The decision of dividing the bus system in two separate networks was made with the aims of

- reaching a better adjustment between demand and offer through the use of bigger vehicles in the main routes and smaller ones in the feeder lines, and
- allowing the authority to make a good planning of the main routes. In effect, considering the difficulty that the design and adjustment over the time of all the bus lines imply, the idea was that the authority should play a more important role in the design of the main routes (where the city development and the patronage are more consolidated), and that the adjustment of the feeder lines should be proposed by the operators themselves. So it was necessary to give them adequate incentives in this direction. On the other hand, the available data and the design tools developed by the

authority were able to give adequate answers to the route design on the main lines, but were not reliable enough in the periphery of the metropolitan area where the demand is spread across and changes quickly.

Some experiences of dividing a bus system into main and feeder lines already existed in other Latin-American metropolitan areas, for instance in Quito and Bogotá.

It was known that the decision of dividing the bus system into two networks would imply an increase in the transfers. Therefore, the route design should avoid a high number of transfers at least inside every network. This meant that in every network overlapping routes allowing direct trips should be preferred to single corridor lines. Jara-Díaz and Gschwender (2003a) showed that the former tends to be a better option when the demand levels are high.

Having these considerations in mind, the following solution was proposed for each bus network: First, in the case of the main bus routes, the objectives of eliminating on-the-street competition and minimising transfers inside the network could be reached by overlapping routes and a payment to the operators mainly dependent on the veh-km (to avoid on-the-street competition). And second, for the local and feeder lines, the objectives of eliminating on-the-street competition and giving incentives to adjust the services and look for demand increases could be reached through separate areas with a monopolistic operator in each of them and a payment to the operators dependent on the number of passengers carried (as an incentive to the adjustment of the services). Again, there is a similarity between this proposition and the systems in other Latin-American metropolitan areas. For example in the *TransMilenio* bus system in Bogotá, the payment to the operators also depends on the veh-km on the main routes and on the passengers carried on the feeder routes.

Nevertheless, the decision-makers finally decided that all bus operators should be paid according to the passengers carried, i.e. in a similar way as they were historically paid. Therefore, the payment system had to be changed in the case of the main lines. The final design considers that the revenue received by the bus operators depends on the number of passengers carried, but is semi-guaranteed, in order to reduce the operators' risk and try to increase the number of bidders: if the actual demand differs from a reference figure, the operators only perceive a drop (or increase) in their income representing 10 % of the demand change.

The new routes and frequencies were designed by using a tool developed by the authority (Sectra, 2001). This design model optimises the frequencies considering the total users' and operators' cost, an approach that has been reviewed by Jara-Díaz and Gschwender (2003b). In addition, routes are generated by using heuristics. More details about this design model can be found in Sectra (2001), Malbran et al. (2004) and Fernández and De Cea (2007).

### 3. New fare structure and ticketing system

There was a high level of consensus among the transport experts about the need of an integrated fare for the public transport system. Moreover, the new routes structure could not be implemented without integrated fares. In effect, as additional transfers would appear, the old pay-each-time-you-board scheme would have implied higher fares for those trips that would already have been penalised by the new transfers.



Travelcards allowing unlimited travel within a period of time (week, month, etc.) were not considered, at least for the first years. Therefore, in this case the integrated fare system implies that the total fare that a passenger has to pay for a trip with transfers is fewer than the addition of the single fares that would have to be paid separately for each stage of the trip. When a transfer is made, a reduced fare (eventually zero) is charged. In order to introduce such a fare structure, a technological change is necessary. A paying method that “remembers” if the passenger already paid is needed, in order to recognise if the user has to be charged the full fare or the reduced transfer fare. The introduction of a smartcard as the main paying device is therefore a key aspect of the proposed system. Nevertheless, it will also be possible to pay in cash, but at a substantially higher fare and without the possibility of fare integration (“emergency” fare).

In addition, a new form of understanding between fare and revenue was needed. Formerly, the operators’ income was the fare. In the new system, the money takes longer to reach the operator, as it first has to be charged to the smartcard, then the smartcard has to be read by the ticket machines inside the vehicles (which subtract the fare from the smartcard) and finally the finance administrator (AFT) has to periodically pay to the operators according to the rules established in the contracts.

Under the new fare system, what the user pays (the fare) will normally be different to what the operator receives for transporting the passenger. Nevertheless, as no direct operational subsidy is considered, equilibrium between incomes and operators’ costs has to be reached. This equilibrium implies that a relationship between fares and operators’ payments has to exist. In fact, given a fare structure, it is possible to estimate the value of each fare as follows:

Let  $d_i$  be the demand for each type of fare, i.e. the number of passengers that pay each one of the different available fares. If  $f_i$  is the value of each fare, which has to be determined, the total income ( $I$ ) paid by the users is

$$I = \sum_i d_i \cdot f_i . \quad (1)$$

On the other hand, let  $p_j$  be the patronage of each operator and  $c_j$  the payment that each operator receives for every passenger, i.e. the unitary cost of each operator for the system. If all the other costs of the system, e.g. the payment to the SIAUT, are assumed fixed ( $A$ ), then the total cost of the system ( $C$ ) can be written as

$$C = \sum_j p_j \cdot c_j + A . \quad (2)$$

If relations between the different fares  $f_i$  are defined ( $f_1 = \alpha f_2$ , etc.) it is possible to obtain the value of every  $f_i$  as a function of  $d_i$ ,  $p_j$ ,  $c_j$  and  $A$ , by equalling (1) and (2). Thus, the dependence of the users’ fares ( $f_i$ ) with the payment to the operators ( $c_j$ ) can be seen. The values of  $c_j$  and  $A$  will be known, as they are results of the different tenders. But the values of  $d_i$  and  $p_j$  have to be predicted in order to calculate equilibrium fares.

Thus a fare structure and the relationships between the different fare types were defined by the authority, but the actual values of the distinct fares will be a result not only of the unitary payments arising from every tender, but also from predictions of the demand. In order to

avoid short-term deficits due to unexpected changes in the demand, a compensation fund (administrated by the AFT) will be maintained.

#### 4. New property structure for the bus industry

The property structure of the bus operators industry had to be changed in order to have larger companies. Each tendering unit should have a fleet of some hundred buses or more<sup>3</sup>. Furthermore, longer periods of concession were considered, especially in the cases in which only new buses were allowed. When this was the case, the concession period should be approximately the same as the allowed vehicles' lifespan (10 years for diesel buses). It was considered that all this would also increase the attractiveness of the business for new operators, and would therefore increase competition in the tendering processes.

After defining the set of roads that would form the network for the main bus routes, the design of these main bus routes using the previously described model yielded approximately 50 main lines. These were finally grouped into 5 tendering units, with some 500 buses each, trying to avoid the coexistence of different operators in the same streets. Nevertheless, in a few cases there will be different operators running lines in the same street. In the case of the feeder lines, 10 areas were defined, trying to follow the existent inner frontiers of the metropolitan area (rivers, hills, roadways, etc.). All the feeder and local lines inside each area were tendered together, and each area needed some 200 buses or less. So a total of 15 tenders were made for the operation of the buses, implying that there would be at the most that number of operators. In order to prevent monopolistic powers in the industry, a single operator could not win more than two main-routes concessions or more than four concessions in total.

#### 5. Awards and penalties scheme

In order to give incentives to the operators aiming to drastically improve the quality of the service, a system of penalties and awards was proposed. Hence a list of faults (e.g. running with open doors, boarding or alighting passengers in an unauthorised place, etc.) and corresponding penalties was defined in the contracts. All the income generated by the penalties will be returned to the operators through a system of awards that considers punctuality and users' satisfaction. A similar penalties/awards scheme is applied in the bus operation in *TransMilenio* (Bogotá).

#### 6. Financial balance

The operation of the new system had to be financed with the income of the fares paid by the users, which should not be significantly higher than the previous fares. No operational subsidy was considered. Though, new cost items would emerge, for example for the ticketing system (AFT), and the information management and users' information (SIAUT). In addition, new infrastructure was needed in those points where there will be a high number of transfers. Some of this new infrastructure has to be paid for by the system itself.

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<sup>3</sup> This means that the small operators with one or a few buses would have to group themselves in larger companies if they wanted to continue in the industry.

An infrastructure plan consisting of the following components is considered:

- 14 km of segregated busways, in addition to the existing 11 km,
- one big interchange station between metro and buses,
- 35 smaller transfer stations,
- road surface and geometric improvements on 63 km of the main roads,
- two strategic road connections and
- improvement of about 5,000 bus stops.

The cost of this infrastructure plan is approximately € 210 million. 25 % of it will be publicly financed, while the other 75 % correspond to private investment that will be charged to the users' fares (Transantiago, 2005c). In addition, a part of the investment in new metro lines will also be charged to the fares.

On the other hand, an important reduction in the bus operation costs was expected. Thanks to the new route design and the complementary conception of the bus lines (between them and the metro), a better match between demand and capacity will be achieved.

Cost estimations considering all these variations showed that a financial equilibrium could be reached, maintaining the fares in similar levels as they were, i.e. with an average normal fare around € 0.45 and an average students' fare of € 0.15.

### **Additional aspects of the plan**

Together with normal 10-12 m long buses, 18 m articulated buses will be introduced in some of the main routes. 25 m biarticulated vehicles were not considered because a competitive market for their provision seemed not to be sure, as too few providers existed. The local or feeder lines will operate with normal buses and 8 m minibuses. All the new buses have to fulfil stricter noise limits and the Euro III emission norm. Excluding the minibuses, all the new vehicles will be partially low-floor with pneumatic suspension and a ramp for wheelchairs (all novelties in Santiago). In two of the five main lines concessions the operators had to acquire a completely new fleet (approximately 1,200 buses) and the concession period is 10 years but can be extended to 16 years if low-emission vehicles are introduced (natural gas, hybrids or electric vehicles). In the other concessions, existing vehicles could be used. The other three main lines concessions have a period of three years, which may be extended if new vehicles are introduced. The duration of the local concessions is five years.

Express services stopping only at the most important bus stops were considered in the main network in order to allow shorter travel times and reduce the fleet size and costs. Preliminary estimations suggested that the main bus fleet could be reduced between 5 % and 9 % through the introduction of express services.

The total fleet will be reduced from 8,000 buses in 2003 to some 5,000 vehicles, but the average size of the buses will increase. So the total capacity of the bus fleet will be reduced by approximately 25 %. The metro will significantly increase its participation in the public transport trips by extending its network and the non-competitive design of the bus routes. In terms of public transport trip stages, the participation of the metro grows roughly from 30 % to 40 %. The reduction of the bus fleet, together with the fulfilment of the Euro III emission norm, will produce a huge decrease in the total emissions of the public transport system.

This is very important because the air quality is a very sensible issue in Santiago where smog is a serious problem every winter.

An important increase in the number of transfers is expected. The previous figure of less than 0.2 transfers per public transport trip will be increased to some 0.8. In spite of this growth, the average trip should still have less than 2 stages.

The payment per passenger received by the bus operators will be adjusted over time according to a mathematical formula established in the contracts, which reflects the impact in the operation costs of changes in the prices of the production factors (fuel, wheels, oil, etc.). The passengers' fares will also be adjusted, according to these changes in the payment to the operators, in order to maintain the financial equilibrium. Neither the authority nor the operators can change the fares at will.

Several measures were considered in order to reduce the financial risk of the bus operators and attract more companies to participate in the tenders. As already explained, the patronage-dependent revenue is semi-guaranteed, as only 10 % of the difference between the actual and the reference demands are transferred to the operators. Other examples of this risk control are:

- A minimum income is guaranteed, varying between 85 % and 60 % of the reference income depending on the type of concession (main lines with/without new buses and feeder lines).
- If at the end of the concession the accumulated revenues are lower than expected, the concession period can be extended up to 24 months until an expected present value of the incomes is reached.
- Revenue adjustments in case of changes in the patronage due to changes in the commercial speeds are considered.
- The compensation fund assures the payment in the first months, even if big mistakes would have been made in the prediction of fares or demands, and assures that the payments to the operators can be made if important drops in the demand occur in the future.
- In order to assure a long-term financial sustainability, it is even established that if the fares reach an upper limit, measures to rationalise the use of the car will be introduced with the aim of increasing public transport use (Transantiago, 2005b).

Without considering public investment in infrastructure, the system has an estimated total yearly cost of € 570 million. From this cost, 43 % corresponds to the main bus routes, 32 % to the metro, 14 % to the feeder and local lines, 5.5 % to the finance administrator (AFT) and the information provider (SIAUT) and 5.5 % to infrastructure (Transantiago, 2005b).

### **Discussion and final comments**

The design of the main aspects of this plan, aiming to improve the public transport system (especially the buses) in Santiago de Chile, began at the end of 2001. The bids for the operation of the buses were awarded in January 2005 to 10 different operators. Some of the winner companies are formed by former bus operators of Santiago, while others correspond to new Chilean and foreign operators. The AFT was in turn awarded to a partnership of the biggest Chilean banks and a technology company in April 2005. The tendering process of the SIAUT was finished during the first semester of 2006. The implementation phase of the new

system began in October 2005 and by the beginning of 2007 all aspects of the new system should be fully implemented.

For the main-routes tenders, between two and seven bids were received for each tender. The highest number of bids was in the tenders where a completely new fleet was required. The lower interest in the tenders with old buses is partially explained by some uncertainty about the market of used buses in Santiago (it is not allowed to import used buses). In the case of the feeder and local area tenders, between three and five bids were received for each one. The financial conditions of the different offers show that a previous agreement among the bidders is highly unlikely to have occurred. In the future, it will be important to be able to maintain the competition in the bus tendering processes. The next round should begin in 2008, and it would be unfortunate to repeat the mistakes of the 1990s, when tendering processes did not achieve competitive conditions.

It still has to be seen whether the winners of the tenders assumed adequate conditions for their bids. An eventual occurrence of the “winner’s curse”, i.e. a too optimistic bidder winning the concession and having financial problems later, cannot be discarded as the tendering procedure selected the best financial (cheaper) offer from those which were technically eligible.

It will also be interesting to discover if the new system will achieve the elimination of on-the-street competition, especially along the main routes. In the local areas, special attention has to be put into the process of attracting new patronage and adapting the services. Do the operators have the right incentives in this direction? This has to be carefully analysed in order to introduce, if necessary, changes in the new tenders.

It is interesting to note that the massive introduction of the contactless smartcard was very attractive for the banks as its technology allows using it also for other purposes as, for example, a money card to pay for retailing. The smartcard will reach a large number of people, many of whom do not have any other bank product because of their low incomes. This aspect was relevant in increasing the interest of the banks in participating in the tender of the finance administrator (AFT). Which new functions (outside the transport system) will be added to the smartcard is still unknown, as this has to be decided by the banks that form the AFT.

There were important technical and political conditions that helped or were useful for the design and implementation of the new system. Technically, the availability of good travel information from origin-destination surveys was crucial, as well as the modelling capacity. It is not to be overlooked that a new model for the design of routes and frequencies was implemented and used, based on a long tradition of modelling knowledge in Chile. In addition, a good knowledge of the particular conditions and deficiencies of the public transport system in Santiago de Chile was indispensable.

Politically, the tendering experiences of the 1990s, together with the law that allowed them, were extremely useful. A change in the complete bus system cannot be imagined in the absence of previous tendering processes. In fact, if the former deregulated bus system were still in force, the authorities would have been practically obliged to negotiate with the operators and the changes of the system would have been much more difficult. Most probably, the changes would have only been able to reach a part of the bus system, maintaining the rest more or less in the same previous conditions, as a niche for the old

operators. This is what happened in Quito (*Trole*), Bogotá (*TransMilenio*) and previously in Santiago when the metro was built and extended without changing anything in the bus system. Now all the operators in Santiago had contracts with an expiring date and after that period they did not have any legal right to continue operating. This facilitated the changes in the system.

Moreover, the public opinion about the bus system and the bus operators was very bad. This helped the authorities to change the system. The strikes made by the bus operators in opposition to the new plan were strongly rejected by the population. Even the arrest, because of the stopping of the traffic in many streets of Santiago, of some of the bus operators' representatives after one of the most serious strike in opposition to the plan, was well received by the citizens and the press. Without this strong support from the population, it would have been much more difficult for the authorities to make progress with the plan. Finally many of the former operators participated in the new bids, after forming companies as required by the tender. The same occurred in Bogotá when the operation of *TransMilenio* was tendered some years before.

In addition, the fact that successful experiences of significant changes in the bus system were known in other Latin-American metropolitan areas (Quito and especially Bogotá), made it easier for the decision-makers to convince themselves that it was possible to succeed with such a plan.

In the other cases there was a strong political figure promoting and defending the plan, for instance in Curitiba, Quito and Bogotá. In Santiago, the lack of such a political leader, together with an unclear institutional design behind the transport system, brought some difficulties that even put at risk the implementation of the plan. It was the president of the country, as the only political authority superior to all the different government departments involved in the design and execution of the plan, who had to decide about key aspects of the implementation.

The creation of a transport authority was one of the key aspects of this plan. So far, a secretary called "*Transantiago*", who has the executive responsibility and coordinates the different government departments related with the public transport system, has taken this role. But will this institutional design be adequate to the future development of the public transport system? Or should a political transport authority be created, concentrating all the responsibilities that are still spread out between different government departments and local authorities? These questions will be analysed in detail in chapter 7, where deeper changes in the institutional organisation of the transport system in Santiago will be proposed, taking into account the experiences of three large European capital cities.

A challenge is the provision of congestion-free infrastructure for the buses. Only a minor part of the main bus routes network (25 km from a total of about 350 km) will have segregated right of way in 2007. Some other main streets have been declared car-free in the morning peak period in the last years, as a way to improve the commercial speed of the buses. But this is a soft policy measure and it is difficult to assume that it will survive over time. In fact, after its introduction in 2000 the length of this car-free network has been reduced year after year. Considering the rapid growth in the motorisation rate, the extension of the physically segregated buslane network should be a priority in order to prevent the future negative impacts of the congestion in the circulation of the buses. The guarantee offered by the authority of compensating the bus operators for losses in the demand which can be

attributed to drops in the commercial speed is an interesting incentive for the authorities to seek avoiding the impact of congestion in the buses.

Other possibilities of improvements can be recognised. Transfers will increase drastically due to the new routes scheme. This is the main loss for the users (probably the only one) in comparison to the previous system. Would it be possible to reduce the number of transfers in the future, as it is known that *ceteris paribus* they negatively affect the demand because of a worse perception of the system's quality? On the other hand, given the high heterogeneity of the population in Santiago in terms of income, it could be interesting to analyse the creation of different public transport products. For example, an expensive high-quality service that should compete with the car for the high-income users, and a cheaper service directed to the low-income population.

The fare integration introduced for buses and metro should be extended to other minor public transport modes in the future, for instance suburban rail and shared-taxis. In addition, the creation of travelcards (unlimited travel in a month, week, etc.), which seem to be an interesting option in order to augment the patronage (Hass-Klau and Crampton, 2002; Matas, 2004), or other price strategies to encourage the frequent use of the system should be analysed. This fares' structure issue will be further analysed in chapter 8 and recommendations for its improvement will be proposed, after comparing the new fare system with the observed systems in three large European capitals.

All the changes in the bus services and the integration between buses and metro represent a deep improvement in the public transport system of Santiago de Chile. Nevertheless, in order to reach a sustainable transport system, further efforts have to be made for example in the internalisation of the costs of the car users and in the encouragement of non-motorised modes.

In the next chapters we will analyse our three study areas. We will start with Greater London.

### 3 Analysis of Greater London and its Transport System

#### 3.1 Socio-economic Aspects in a Multi-racial World-city

The population of Greater London, the capital city of England and the United Kingdom, reached its peak of 8.6 million in 1939. Driven by policies of decentralisation and the decline of the industries, Greater London's population fell significantly to 6.8 million people by 1983. However, since 1989 Greater London has been one of the most rapidly growing major metropolitan areas in Europe, adding half a million people in fifteen years, with 800,000 more expected in the next 15 years. In 2004, Greater London's population was estimated to be almost 7.4 million people (table 3.1), being the largest city in the European Union. 8.1 million people are expected to live in Greater London by 2016, as shown in figure 3.1 (GLA, 2004). Greater London has an average density of 4,700 people/km<sup>2</sup> (CfIT, 2001), but some central areas can have more than 10,000 people per square kilometre (see figure 3.5 below). The London metropolitan area or commuter belt has an estimated population of some 14 million (Demographia, 2007a).

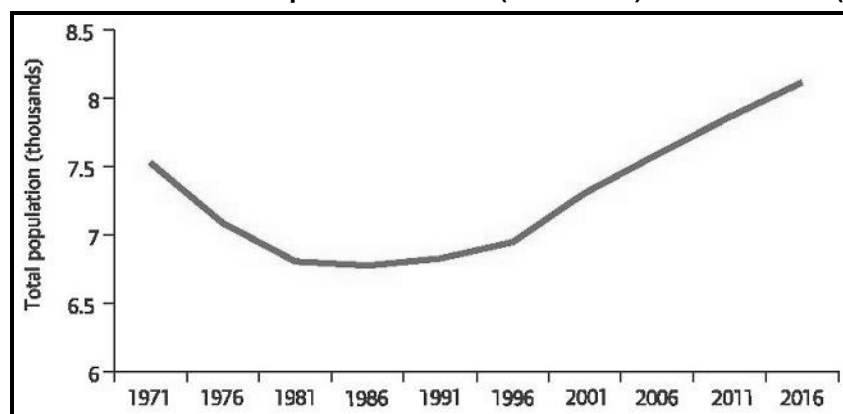
**Table 3.1: Population in Greater London by Age** <sup>(a)</sup>

Year	0-14 years	15-64 years	65 and over	TOTAL
1971	1.6	4.9	1.0	<b>7.5</b>
1981	1.2	4.5	1.1	<b>6.8</b>
1991	1.3	4.6	0.9	<b>6.8</b>
1996	1.4	4.6	0.9	<b>6.9</b>
2001	1.4	5.0	0.9	<b>7.3</b>
2002	1.4	5.1	0.9	<b>7.4</b>
2003	1.4	5.1	0.9	<b>7.4</b>
2004	1.3	5.2	0.9	<b>7.4</b>

<sup>(a)</sup> Population in million

Sources: TfL (2003, 2005d)

**Figure 3.1: Greater London's Population: Actual (1971-2003) and Predicted (2004-2016)**



Source: GLA (2004 p25)

Greater London is one of the most ethnically diverse metropolitan areas in the world. According to the last census, in 2001, more than 300 languages are spoken and 50 non-indigenous communities with a population of more than 10,000 live in Greater London (Guardian Unlimited, 2005). Nearly one third of the Londoners are from black and minority ethnic communities, including some mainly white minority groups such as Irish, Cypriot and



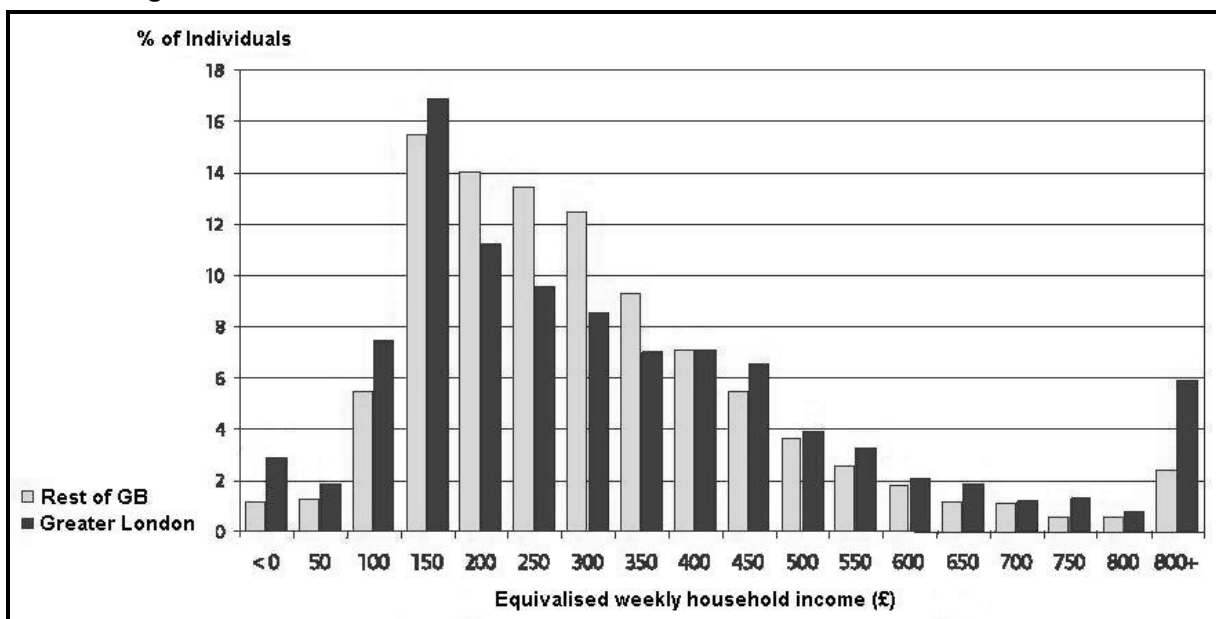
Turkish communities. A significant growth in black and minority ethnic communities is projected over the next years. International in and out-migration has been high and is projected to remain so. The impact of migration has had a rejuvenating effect on London's age structure; people moving to London tend to be young adults, such as students or first time employees, while those moving out are mostly older workers, retired people and young families (GLA, 2004).

The annual per capita gross domestic product (GDP) in Greater London was US\$ 25,300 in 2002. While Greater London has just 12 per cent of the UK's population, it accounts for 18 per cent of the UK's total output. Greater London has one of the most internationally competitive business and financial service sectors in the world. The UK capital competes with Paris, Frankfurt and New York for major businesses rather than against the UK's other major metropolitan areas (GLA, 2004).

According to the Greater London Authority (GLA, 2004), London's economy is growing and 636,000 new jobs are expected to be created until 2016. There has been an important change in London's employment structure in the last 30 years, as 600,000 jobs in business services were created and 600,000 jobs in manufacturing were lost. After business services, the second main driver of jobs creation has been other services, primarily dominated by the leisure and people-orientated services sector, and hotels and restaurants that are closely linked to the growth of tourism. The retail sector expanded significantly in the 1990s, following earlier losses, as did employment in health and education. Most other sectors declined in employment.

However, Greater London has the second highest unemployment rate in England, after the North East of England. While the unemployment rate for white Londoners is in line with the rate for white people in the rest of the UK at 5.1 per cent, the rate for ethnic minorities is 13.5 per cent (GLA, 2004). On the other hand, Greater London has the highest GDP per capita in the UK. However, it has higher concentrations of individuals in both high and low-income bands than the rest of Great Britain as can be seen in figure 3.2.

**Figure 3.2: Greater London and Great Britain Income Distributions 1999-2000**



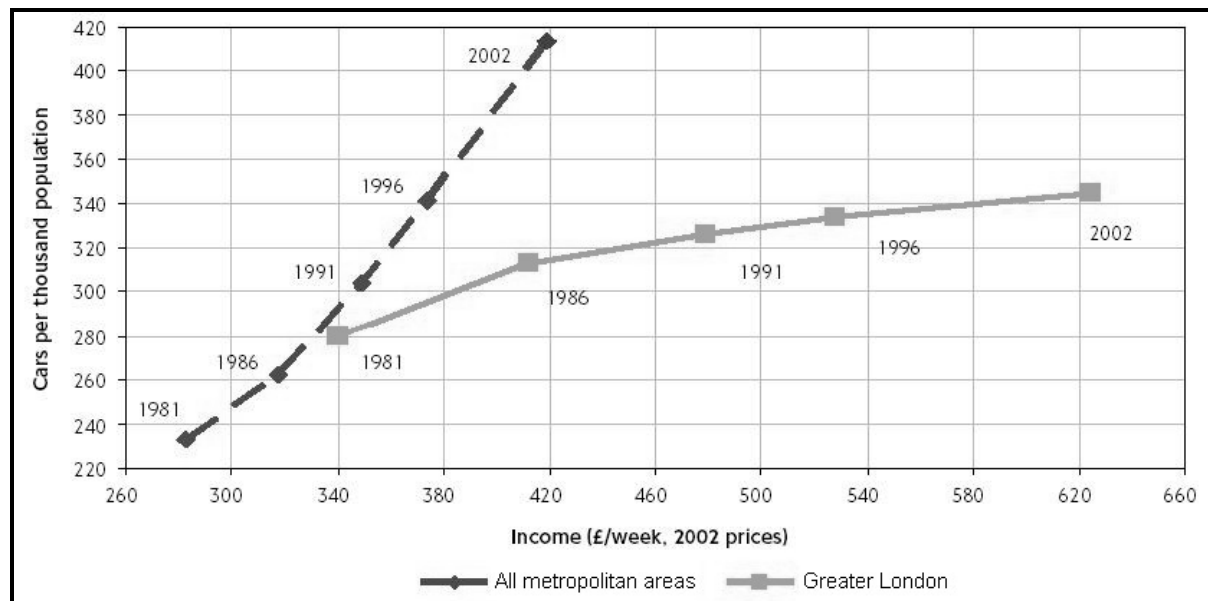
Source: GLA (2004 p32)

Housing costs in Greater London are both a cause and a consequence of the polarisation of incomes. Before housing costs are taken into account, the ratio between disposable incomes at the top and bottom of the income distribution is 5:1 in London. After housing costs, the ratio rises to 7:1 (GLA, 2004). According to the United Nations Development Programme, the richest 20 % of the population in Great Britain have an income 7.2 times higher to the poorest 20 % (UNDP, 2005a).

Car ownership rates in Greater London showed little change in the last years, having risen only 3.6 % between 1998 and 2002. Over a third of Greater London households did not own a car in 2002, when the motorisation rate was around 350 cars every 1,000 inhabitants. By contrast, the motorisation rate in the metropolitan areas outside London showed a 16 % increase over the same period, from 360 to 410 cars every 1,000 inhabitants (TfL, 2003).

Figure 3.3 shows how car ownership levels and trends differ in Greater London and the other metropolitan areas in the UK. Greater London shows a much lower rate of increase despite strongly rising earnings.

**Figure 3.3: Car Ownership and Income Levels 1981-2002**



Source: TfL (2003 p19)

Greater London was established in 1965 as an administrative unit covering the London metropolis. Since 2000 its authority consists of an elected Mayor and a 25-member Assembly. It is divided into 32 boroughs, with a status similar to metropolitan districts, and also the City of London, which is a City Corporation and has a number of additional roles (ONS, 2005; GLA, 2004 p vii). The 32 boroughs and the City of London are shown in figure 3.4, where the dark line shows the boundaries between what is usually called “inner” and “outer” London.

The population in inner and outer London in the last years is presented in table 3.2. Table 3.3 shows the number of households in inner and outer London and the average size of the households. It can be seen that outer London has a higher number of households and inhabitants than inner London.

Figure 3.4: Boroughs in Greater London

Table 3.2: Population in Inner and Outer London <sup>(a)</sup>

Year	Inner London	Outer London	TOTAL
1971	3.0	4.5	7.5
1981	2.5	4.3	6.8
1991	2.6	4.2	6.8
1996	2.6	4.3	6.9
2001	2.8	4.5	7.3
2004	2.9	4.5	7.4

<sup>(a)</sup> Population in million

Sources: TfL (2003, 2005d)

Table 3.3: Households in Inner and Outer London

Year	Inner London (million)	Outer London (million)	TOTAL (million)	Household size
1981	1,04	1,60	2,64	2.54
1991	1,14	1,70	2,84	2.39
1996	1,20	1,77	2,97	2.32
2001	1,22	1,80	3,02	2.35

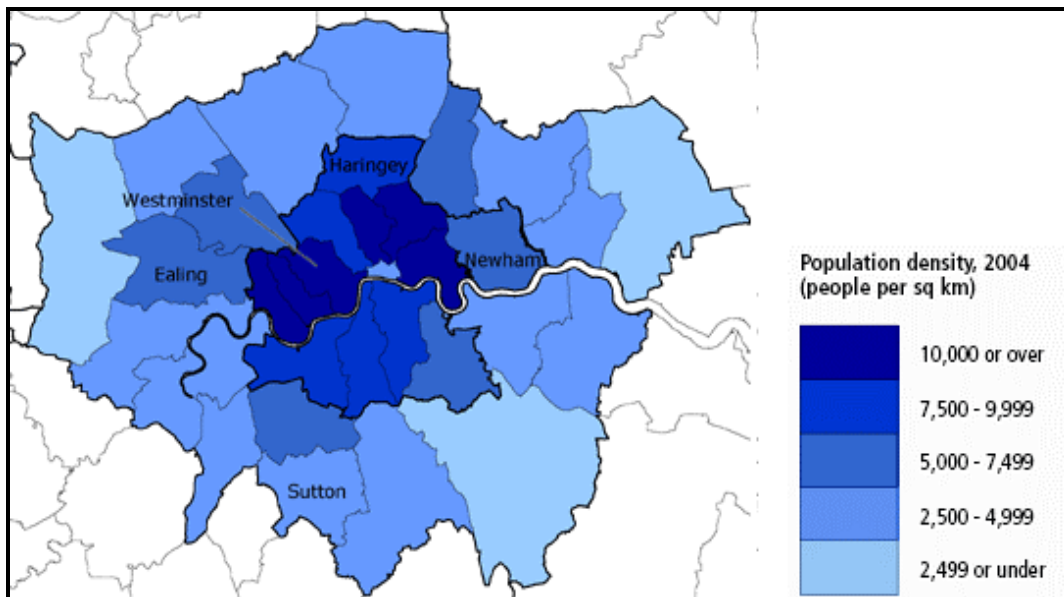
Source: TfL (2003)

Greater London is a polycentric metropolitan area. Many of these centres have a long history as the focus of their community's activities, often dating back to the original settlements, such as Hampstead or Richmond. The centre (the City, Westminster and surrounds) has always been a powerful place of government, trade and culture. London's patterns of growth have helped to create significant differences between its sub-regions. For example, east London has been more industrial in character and, owing to 20th century industrial decline, has suffered greater problems of low income and social disadvantage than most areas in west

London. London north of the river has historically accommodated the main centres of government, business and culture, compared to the more predominantly residential nature of south London (GLA, 2004).

The highest population densities are observed in the central boroughs (figure 3.5), with more than 10,000 people per square kilometre in Hammersmith & Fulham, Kensington & Chelsea, Westminster, Islington, Hackney and Tower Hamlets.

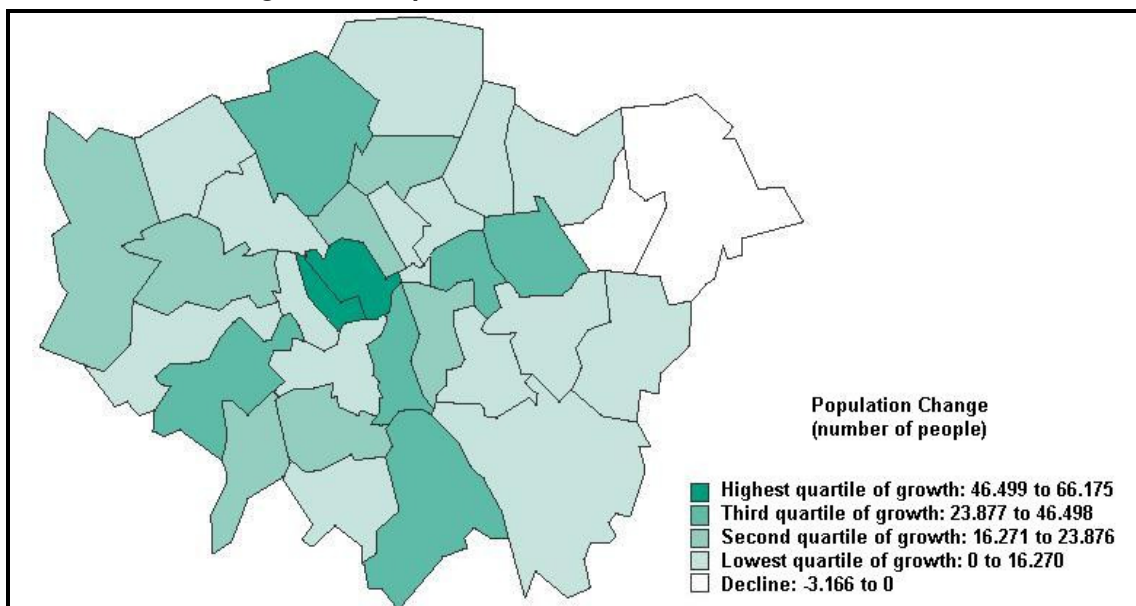
**Figure 3.5: Population Density in 2004**



Source: ONS (2006)

Almost all boroughs (with the exception of Barking & Dagenham and Havering) have seen their populations increase in the past decade. The most acute build-up of population has been in the centre and the boroughs to the south west, reinforcing the historic trend towards residential development in south London (figure 3.6).

**Figure 3.6: Population Growth between 1989 and 2003**



Source: GLA (2004 p22)

## 3.2 Modal Split

According to Transport for London (TfL, 2003) 25.7 million trips are made in Greater London in an average day (considering weekdays and weekends). As can be seen in table 3.4, more trips are made by car/motorcycle (42.8 %) than public transport (33.8 %).

**Table 3.4: Modal Split Average Day in Greater London in 2003**

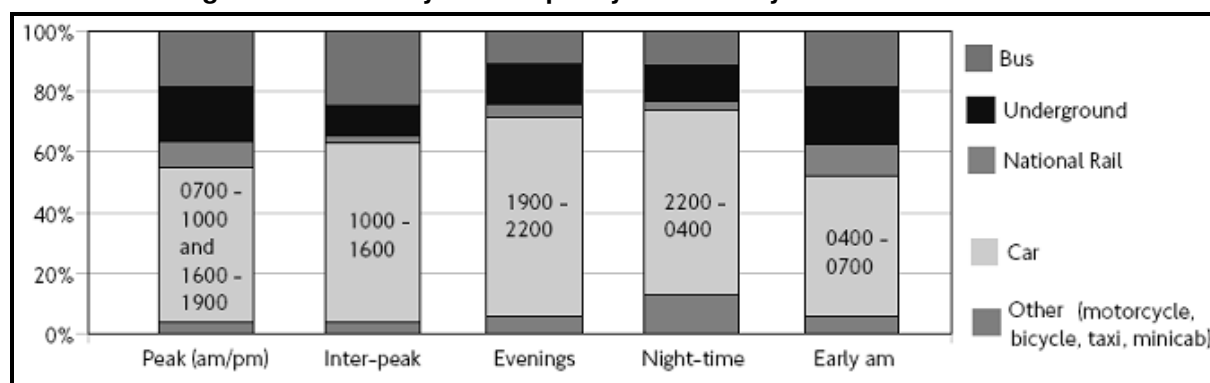
Transport mode	Trips (million)	%
Bus	4.2	16.3
Underground	2.6	10.1
Rail	1.8	7.0
DLR <sup>(a)</sup>	0.1	0.4
Car/motorcycle	11.0	42.8
Taxi	0.2	0.8
Walking	5.5	21.4
Bicycle	0.3	1.2
<b>TOTAL</b>	<b>25.7</b>	<b>100.0</b>

<sup>(a)</sup> Docklands Light Railway

Source: TfL (2003 p21)

Figure 3.7 shows the modal split in different periods of a weekday. It can be seen that the public transport share of trips is higher in the peak periods (especially in the morning) than in the rest of the periods.

**Figure 3.7: Weekday Modal Split by Time of Day in Greater London <sup>(a)</sup>**



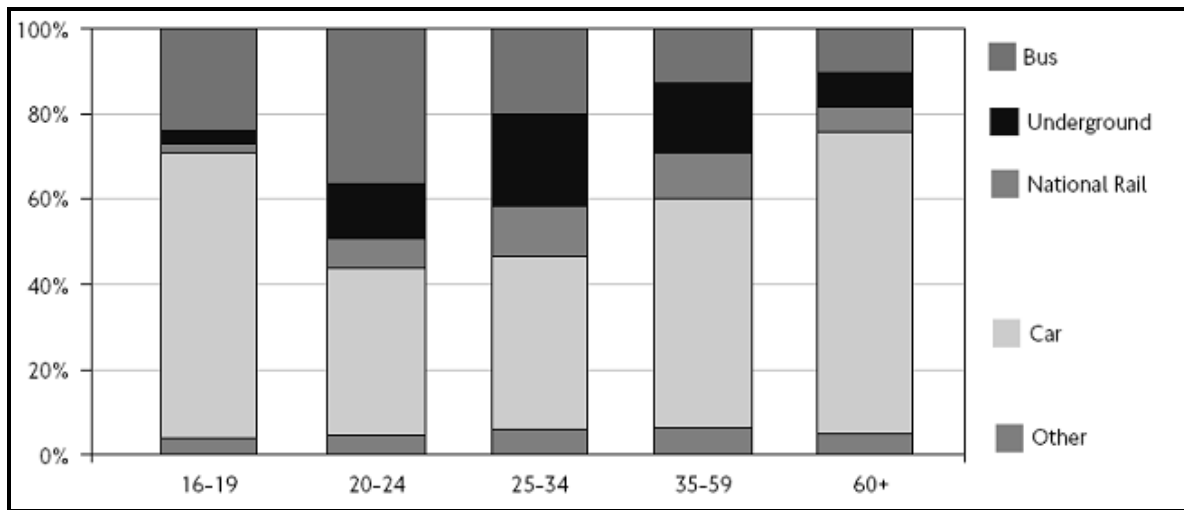
<sup>(a)</sup> Considers trip-stages made by Greater London residents.

Source: TfL (2003 p29).

On the other hand, figure 3.8 shows the modal split for different age groups. The 20-34 year old age group is the most frequent user of public transport in the Greater London area. From them, the 20-24 age group uses more bus than rail modes, while the 25-34 age group does exactly the opposite.

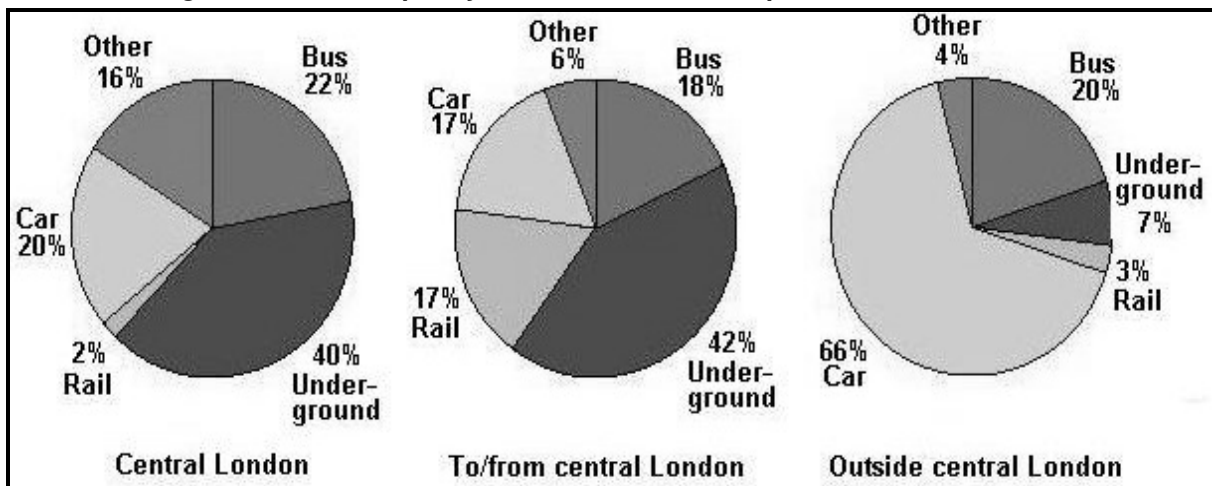
In figure 3.9, the modal split of the motorised trips (i.e. excluding walking and bicycle) is presented for different areas. This figure shows that public transport accounts for 64 % of travel in the central area of London and for 77 % of trips to and from the central area. Outside the central area, the car is the principal mode of travel with 66 % of trips. Central London is a 27 km<sup>2</sup> area (1.7 % of Greater London), formed mainly by the City of London, the centre and south of Westminster, and also small parts of the boroughs of Islington, Camden, Kensington & Chelsea, Lambeth and Southwark.

**Figure 3.8: Weekday Modal Split by Age Group in Greater London <sup>(a)</sup>**



<sup>(a)</sup> Considers trips made by Greater London residents.  
 Source: TfL (2003 p32).

**Figure 3.9: Modal Split by Area for Motorised Trips in Greater London <sup>(a)</sup>**

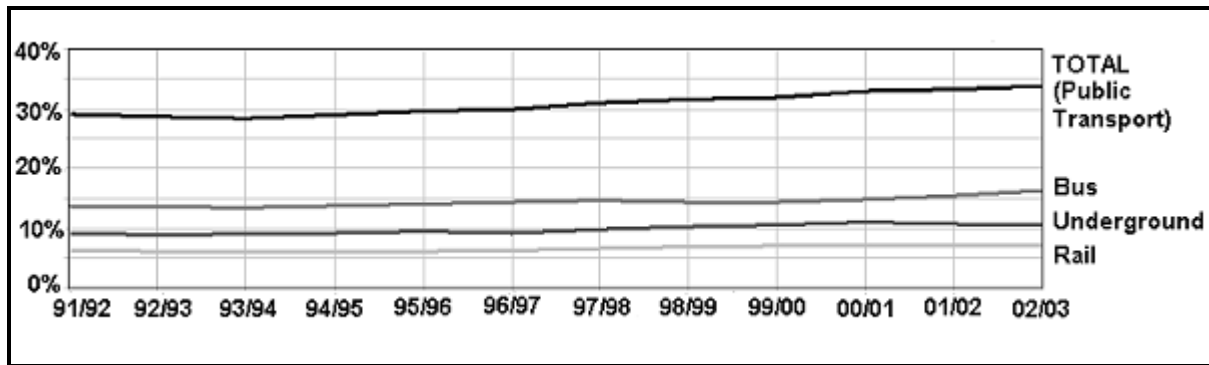


<sup>(a)</sup> Considers trip-stages made by Greater London residents.  
 Source: TfL (2003 p30).

In figure 3.10 the evolution of the public transport modal share is presented. Public transport's share of trips rose from 29 % to 32 % during the 1990s and continued rising thereafter.

In 2002 more than 1 million people were estimated to have entered central London on a typical weekday in the morning peak (between 7am and 10am). These trips are mainly done by public transport, as can be seen in table 3.5. Moreover, the public transport modal share has been rising in the last years, while the private car use has fallen. Between 1992 and 2002, 45,000 fewer trips were made by car.

Figure 3.10: Public Transport Modal Evolution in Greater London <sup>(a)</sup>



<sup>(a)</sup> Non-motorised trips are also considered in the total trips when calculating the percentages.  
Source: TfL (2003).

Table 3.5: Modal Split Evolution in Central London, Morning Peak

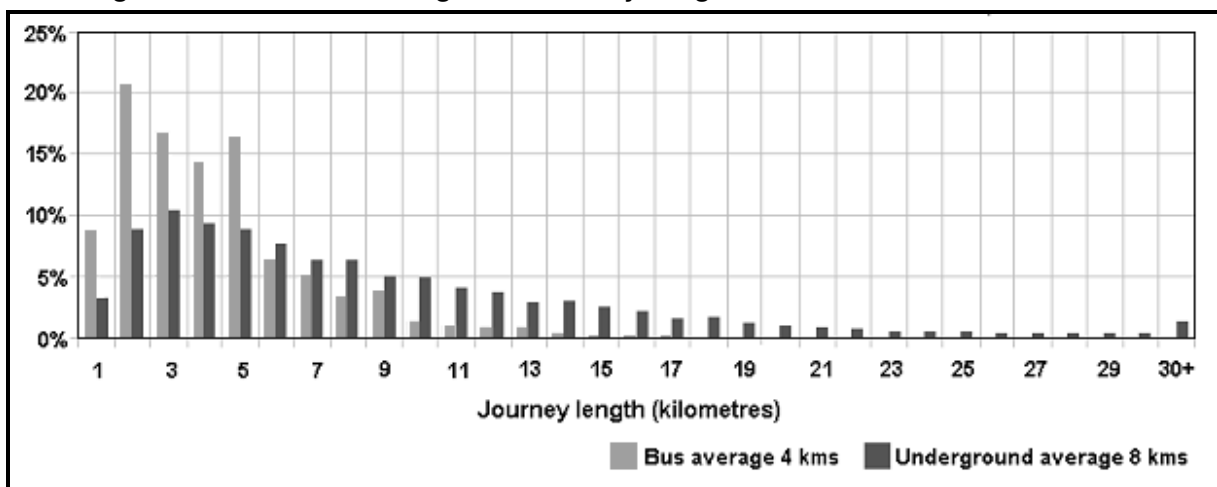
Year	Public Transport (%)	Private Transport (%)	Others (%)
1992	82.9	16.2	0.9
1997	83.3	14.9	1.8
2002	87.0	11.2	1.8

Source: TfL (2003)

### 3.3 Other Characteristics of the Trips

Despite the continuing growth in journey lengths, the majority of trips in Greater London are still relatively short, half of them being less than 2 km long (TfL, 2004a). Figure 3.11 shows the distance travelled in the main public transport modes. It can be seen that the average distance travelled by underground is higher than by bus, a fact that is explained by the higher commercial speed of the underground and its large network.

Figure 3.11: Bus and Underground Journey-Length Distribution in Greater London



Source: TfL (2003 p15).

Table 3.6 presents the average trip length and speed for every mode. Rail modes are the fastest and the longest trips are made by rail and car. The slowest modes are the non-motorised ones, in which the shortest trips are made.

**Table 3.6: Trip Length and Speed by Mode in Greater London in 2003**

Transport mode	Average trip length (km)	Average speed (km/h)
Bus	3.7	18
Underground	7.8	32
Rail	28.3	56
DLR <sup>(a)</sup>	5.1	29
Car/motorcycle	11.6	29
Taxi	8.4	23
Walking	0.8	5
Bicycle	3.2	16
<b>TOTAL</b>	<b>8.7</b>	<b>24</b>

<sup>(a)</sup> Docklands Light Railway

Source: TfL (2003)

Regarding travel times, table 3.7 shows the average times involved in the travel to work, separated by area of workplace. In general, the more central the workplace, the longer is the travel time. The differences in the travel times between modes are mainly explained by distinct travel distances. For instance rail, which is the fastest mode, has the longest travel times because the trip distances are the longest.

**Table 3.7: Travel Times to Work, by Area of Workplace <sup>(a)</sup>**

Mode	Central London	Rest of Inner London	Outer London	All Greater London
Bus	50	40	37	<b>42</b>
Underground	50	53	52	<b>51</b>
Rail	71	66	61	<b>69</b>
Car	54	39	31	<b>35</b>
Motorcycle	38	30	24	<b>31</b>
Walking	20	14	13	<b>14</b>
Bicycle	31	27	19	<b>25</b>
<b>AVERAGE</b>	<b>57</b>	<b>42</b>	<b>31</b>	<b>43</b>

<sup>(a)</sup> Times in minutes

Source: TfL (2003)



### 3.4 Transport Authority: Transport for London

Transport for London (TfL) is the local authority responsible for the capital's transport system. It is accountable to the Mayor of London and is responsible for delivering the Mayor's transport strategy.

TfL manages London's buses, the Underground, the Docklands Light Railway (DLR) and London trams. It also runs London's river services, Victoria Coach Station and London's Transport Museum. As well as operating the central London congestion-charging scheme, TfL manages a 580 km network of main roads (including 900 bridges and 10 major tunnels), all of Greater London's 4,600 traffic lights; it regulates taxis and the private hire trade. TfL also coordinates schemes for transport users with mobility impairments as well as running Dial-a-Ride schemes. In addition, TfL undertakes works in order to improve conditions for walkers, cyclists, drivers and freight and it implements proposals for reducing congestion on London's streets (TfL, 2004b). A more detailed analysis of Transport for London can be found in chapter 7.

### 3.5 Car Travel

There are some 4,600 traffic signals in Greater London, all of which are owned and maintained by TfL, as explained before. Over half of these can be remotely adjusted and 1,200 are managed through an advanced traffic control system called SCOOT, which allows timings to be adapted automatically to suit local changes in traffic volume and direction (TfL, 2004c).

Table 3.8 shows the occupants per vehicle entering central London during the morning peak. The average car occupancy has practically remained fixed at some 1.3 people per car between 1992 and 2004.

**Table 3.8: Car Occupancy Evolution in Greater London <sup>(a)</sup>**

Year	Average car occupancy
1992	1.32
1998	1.34
2004	1.37

<sup>(a)</sup> Vehicles entering central London during morning peak  
Source: TfL (2005d p8)

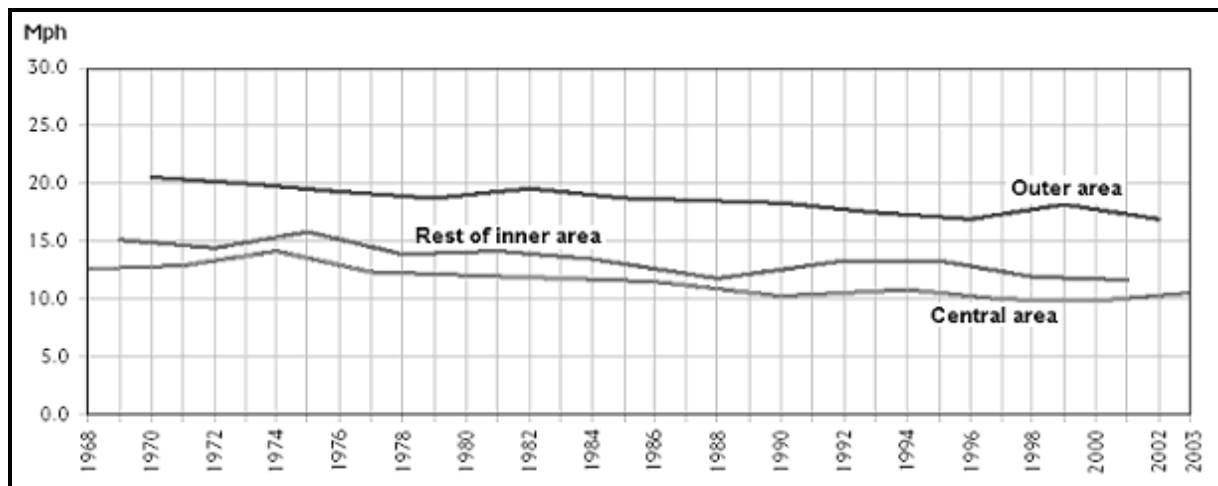
The number of licensed taxis has been growing by about 2 % annually in Greater London. Table 3.9 shows that there were 21,000 licensed taxis in 2005.

Traffic speeds have been declining in Greater London since 1970 (figure 3.12). However, following the introduction of a congestion-charging scheme in central London in 2003, traffic speeds averaged 17 km/h (10.6 mph), an increase of 7 % over 2000 (TfL, 2003).

**Table 3.9: Taxis in Greater London**

Year	Licensed taxis
1985	13,800
1990	16,300
1995	18,300
2000	19,400
2005	21,000

Source: TfL (2005d)

**Figure 3.12: Traffic Speed Evolution in Greater London, Morning Peak**

Source: TfL (2003)

### 3.6 The Underground and Suburban Rail Systems

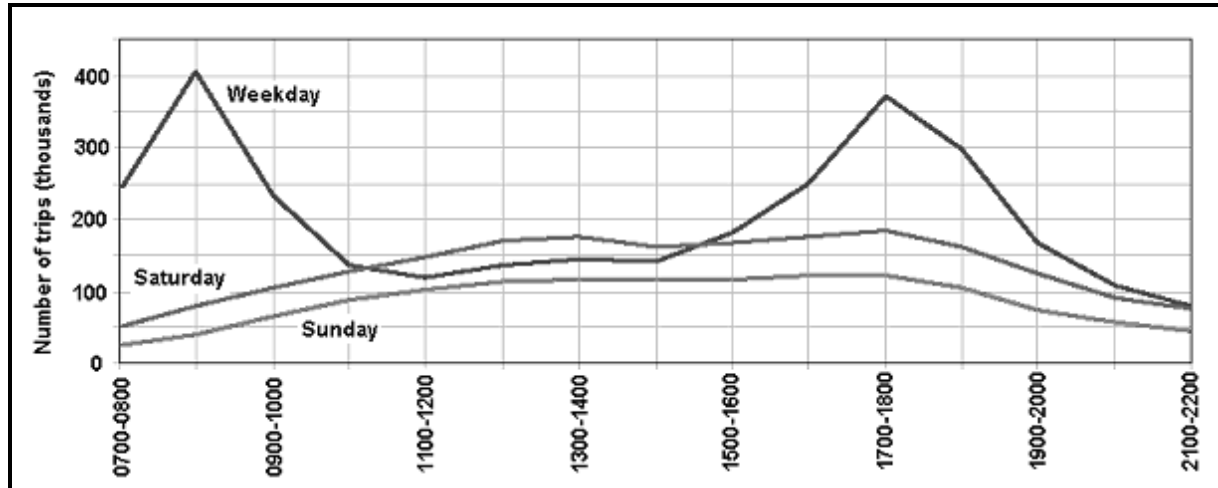
In 2006 Greater London had 12 **underground** lines operating in a 408 km long network, mostly located to the north of the River Thames. There were 255 underground stations and 21 depots and workshops. The London Underground had 598 trains with a total of 4,070 cars. In one year, nearly 70 million train-km were run, providing approximately 60,000 million passenger place-km (TfL, 2006c; LUL, 2003; EMTA, 2004a). In 2005, 976 million passenger journeys were made, yielding 7,606 million passenger-km (TfL, 2005d, p19).

In 2002, the London Underground operated 19 hours a day and the vehicles were 23 years old in average (EMTA, 2004b). Its average commercial speed was 33 km/h in 2006 (TfL, 2006c).

The responsibility for the Underground was transferred to TfL in 2003 and London Underground was merged with TfL (EMTA, 2004a p63). Its history dates back to 1863 when the world's first underground railway opened in London.

Figure 3.13 shows that metro travel has sharp peak times on weekdays, more than doubling the number of trips of the off-peak. Weekend travel patterns show a more even distribution of journeys.

Figure 3.13: Trips by Hour in London Underground (2002)



Source: TfL (2003)

Although metro fares have increased in the last years (table 3.10), its growth has been at a smaller rate than the index of London weekly earnings per head (TfL, 2003).

Table 3.10: Fare Evolution in London Underground

Year	Average fare per passenger-km <sup>(a)</sup>
1971	10.7
1981	14.6
1993	13.7
1997	15.5
2002	15.7

<sup>(a)</sup> Pence, at 2002 prices

Source: TfL (2003)

Besides the 12 Underground lines, in 2006 Greater London had 31 km of a fully automatically operated rail system called **Docklands Light Railway** (DLR). It had 38 stations and 47 trains with a total of 94 vehicles (DLR, 2003; TfL, 2006d).

In a supply of 3.3 million train-km in 2005, 50.1 million passenger journeys were made, implying 243 million passenger-km. The average commercial speed of the DLR was 29 km/h (TfL, 2003, 2005d p23).

Docklands Light Railway, a subsidiary of TfL, owns the infrastructure of this line and franchises its operation to private companies (EMTA, 2004a p63). An extension of the DLR network to London City Airport was recently constructed, and a further extension to Woolwich Arsenal is planned to open in 2008 (TfL, 2004e).

In addition, there were 788 km of **National Rail** lines in Greater London in 2003 (TfL, 2004e). Ten private companies operate in this network, with an average speed of 56 km/h. In 2004, 502 million National Rail trips were made in Greater London, half of them having both the origin and the destiny inside Greater London (TfL, 2005d p 22). 69 % of the National Rail trips in Greater London are made for work purposes (TfL, 2003).

The responsibility for the management of the rail services collectively known as the North London Railway will be transferred to TfL by 2007. TfL will manage the concession, which will be run under the name "Overground" by a train operator to standards specified by TfL. London Overground services will also run on the East London Railway when it opens in 2010 (TfL, 2006e, 2006f).

After the closure of the last old tramways in 1952, a new generation of trams was introduced in Greater London in May 2000, after over 12 years of development and construction. In 2006 the Croydon **Tramlink** had 3 lines running over a 28 km long network with 38 stops. The vehicles are 30 m long and each of the 24 trams can carry up to 240 people. Croydon Tramlink has seen a 3 % year-by-year growth in patronage with approximately 22 million passenger journeys being made in 2004/05 (12 months). The system is operated by a concessionaire, Tramtrack Croydon Ltd, on behalf of Transport for London (TfL, 2004f; 2005d p24; 2006g).

Two new tram schemes are being planned for London. The first is the West London Tram, which may open by 2012 (TfL, 2004g). The second is the Cross River Tram, which could also be opened by 2012 (TfL, 2004f). Extensions to the existing Tramlink are being analysed as well.

### 3.7 Bus System

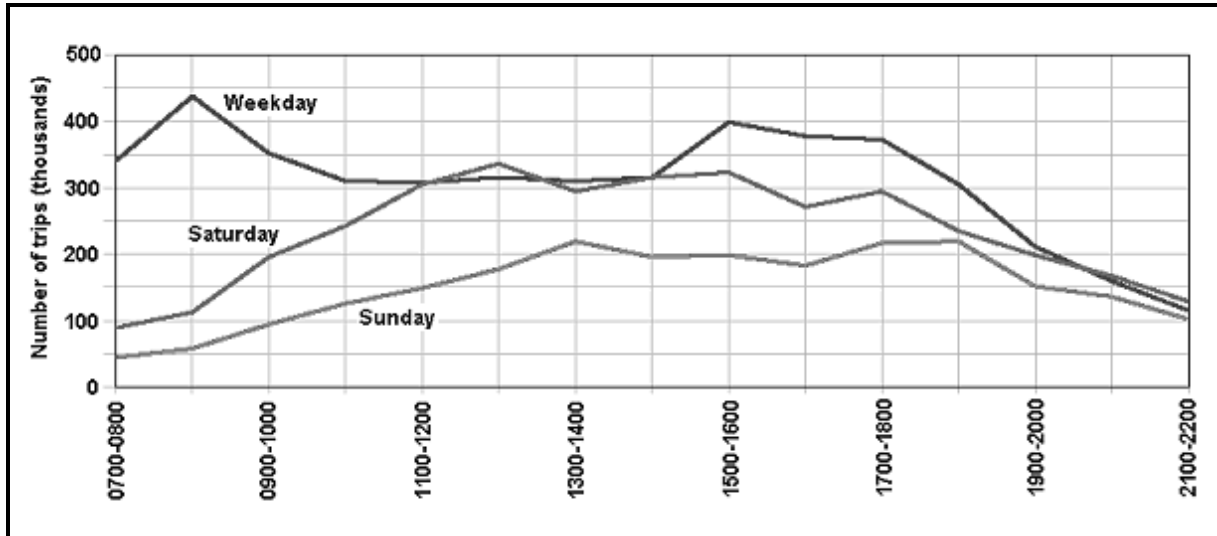
In 2005, Greater London had more than 700 bus lines over a 3,730 km long network with some 17,500 stops. There were over 6,800 scheduled buses and approximately 20 operators (EMTA 2005b p71; TfL 2006h). 450 million veh-km were run and 1,793 million passenger journeys were made, yielding 6,755 million passenger-km. The average number of passengers per bus was 15 (TfL, 2005d p17). The average commercial speed of London Buses was 16,5 km/h in 2002. The fleet was 7.4 years old in average and 85 % of it corresponded to low floor buses (EMTA, 2004b). 90 % of all Greater London households are within 400 m of a bus service (TfL, 2003).

London Buses, which is part of TfL, manages the bus services. It plans the routes, specifies service levels, monitors the service quality and is responsible for bus stops. The bus services are run by private operators working under contract to London Buses (EMTA, 2004a p63).

Figure 3.14 shows that bus travel has two peak times on weekdays, but these peaks are not so high as in the case of the Underground (figure 3.13). Weekend travel patterns show a more even distribution of journeys.

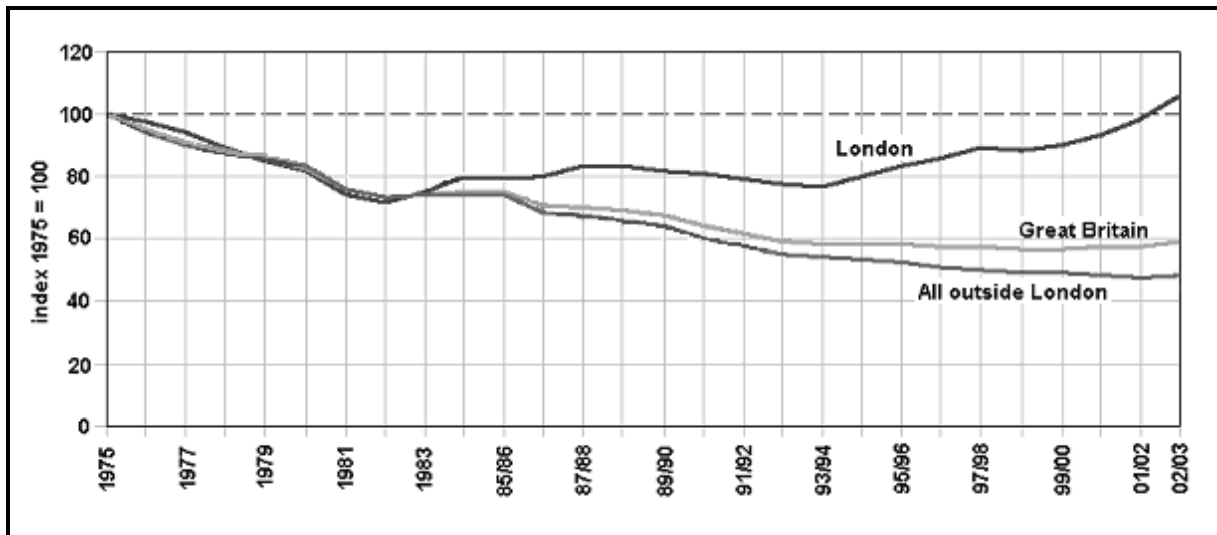
Bus passengers have been declining in the UK since 1975 (figure 3.15). Nevertheless, London Buses patronage stabilised during the 80s and rose since 1993 reaching in 2003 the volume that it had in 1975.

Figure 3.14: Trips by Hour in Greater London Buses (2002)



Source: TfL (2003)

Figure 3.15: Bus Passenger Journey Trends across the UK



Source: TfL (2003)

Matthews et al. (2001) analysed the average weekly bus trip rates in Greater London, based on National Travel Survey data. Some of their results are presented in the following tables. It can be seen that a higher number of bus trips per person is found in Inner London in comparison to Outer London. On the other hand, women use buses more than men, and inhabitants of households without cars have much higher bus trip rates than those from households with cars. Regarding age groups, people over 60 years have the highest bus trip rate, followed by the persons between 20 and 29 years.

Table 3.11: Average Weekly Bus Trips by Area in 1995/97

Area	Bus trip rate
Inner London	2.81
Outer London	1.97
<b>Greater London</b>	<b>2.30</b>

Source: Matthews et al. (2001)

**Table 3.12: Average Weekly Bus Trips by Gender in 1995/97**

Gender	Bus trip rate
Male	2.02
Female	2.56

Source: Matthews et al. (2001)

**Table 3.13: Average Weekly Bus Trips by Number of Household Cars in 1995/97**

Cars in the household	Bus trip rate
None	4.03
One	1.69
Two or more	0.68

Source: Matthews et al. (2001)

**Table 3.14: Average Weekly Bus Trips by Age Group in 1995/97**

Age group	Bus trip rate
19 years or less	2.19
20-29	2.44
30-39	2.12
40-49	2.24
50-59	1.86
60 years or more	2.82

Source: Matthews et al. (2001)

Bus fares increased in the last decades, but they have fallen in the last years, as can be seen in table 3.15. In 2002 the real fare was at a level comparable to the 70s.

**Table 3.15: Fare Evolution in London Buses**

Year	Average fare per passenger-km <sup>(a)</sup>
1971	12.7
1981	12.4
1993	14.7
1997	14.9
2002	12.2

<sup>(a)</sup> Pence at 2002 prices

Source: TfL (2003)

There have been interesting improvements in London buses in the last years. Off-peak frequencies have been increased and more night services have been introduced. The number of night buses increased by 28 %. Users' information has been improved in several forms. Over 300 local bus maps were designed, trying to reach the simplicity of the well-known Tube map. All London Underground stations now have bus maps and information on local bus routes, so it should be easier to find out how to continue the journey from the station. Five large bus maps covering different parts of Greater London were also designed. A free Internet service called "Journey Planner" was also developed. It allows finding out the quickest and easiest routes for a specific public transport trip across Greater London. It is possible to register to receive emails and text messages into a PC or a mobile phone

providing real-time travel information on bus journeys and other modes of public transport (TfL, 2004h).

### 3.8 Central London Congestion Charging Scheme

The congestion-charging scheme was introduced in February 2003. The scheme implies that every car driver has to pay 8 pounds (€ 12) per day if he enters a defined area in central London. The congestion-charging scheme operates between 07:00 and 18.30 Monday to Friday, excluding Public Holidays. By law, all money raised from congestion charging has to be spent on London's transport facilities. During its first year of operation congestion charging generated £68 million (€ 102 million) for spending on transport improvements (TfL, 2004e). Routes and frequencies of buses were improved in order to offer a better option for those who are not willing to pay the charge.

In 2003 approximately 550,000 congestion charge payments were made each week. 65,000 to 70,000 daily car trips were no longer made to the charging zone during charging hours. From these, between 50 % and 60 % have transferred to public transport, 20 % to 30 % now divert around the charging zone (these being trips with both origins and destinations outside of the zone), and 15 % to 25 % have made other adaptations, such as changing the timing of trips (TfL, 2004d).

Congestion (delays) was reduced by 30 %, and the volume of traffic by 15 %. Though, there is no evidence of systematic increases in traffic outside of charging hours on weekdays or weekends in response to the introduction of the charge. In addition, there is no evidence of systematic increases in traffic on local roads outside the charging zone during charging hours, in response to the introduction of the charge (TfL, 2004d).

Comparative analyses of the many influences on the central London economy throughout 2003 suggest that the direct impact of congestion charging has been small. London's economy has been subject to a wide range of influences during 2003. Collectively, these have had a much greater impact on the central London economy than congestion charging. They have also made the task of identifying and quantifying congestion-charging-related impacts more difficult (TfL, 2004d).

During a typical weekday morning peak, 106,000 passengers entered the congestion-charging zone on 560 **buses** in Autumn 2003. This represents a 38 % increase in patronage and a 23 % increase in service provision compared with 2002, yielding an increase in average occupancies per bus. Transport for London estimates that about half of the increased patronage is due to congestion charging (TfL, 2004d).

The reliability of bus services has improved, both within the charging zone and more widely across Greater London. Within the charging zone additional waiting time due to service irregularity fell by 30 %, whereas disruption due to traffic delays fell by 60 %. Overall bus speeds within the charging zone improved by 6 %. The improvement within the zone is greater than that observed in other areas of Greater London (TfL, 2004d).

After the introduction of the congestion charge, bus journey times in central London decreased by 15 %. This improvement is not only explained by the reduction in the congestion levels, but also by a better enforcement of bus lanes (there are over 1,400 cameras monitoring bus lanes) and by the introduction of “pay before you board” in central London in August 2003. As passengers do not have to pay in the bus anymore, boarding times are faster implying better commercial speeds (TfL, 2004h).

This combined strategy of congestion charging and improved bus services has resulted in the first ever modal shift from private car usage to public transport, against the trend elsewhere in the UK and the world (TfL, 2004e).

In addition, congestion charging has had a very positive effect on **cycling** levels in central London. Cycle flows into the charging zone have increased by around 30 % (TfL, 2004i). Despite the recent rise, the level of cycling in London, less than 2 %, is low compared to other European metropolitan areas: 4.5 % in Vienna, 10 % in Berlin, 13 % in Munich, 20 % in Copenhagen and 28 % in Amsterdam (TfL, 2004i).

An analysis about the public transport fare system and the financial aspects of public transport in Greater London is presented in chapter 8. In the following chapter we will analyse the transport system of Berlin.



## 4. Analysis of Berlin and its Transport System

### 4.1 Socio-economic Description and Car Ownership

Berlin has a surface of 892 km<sup>2</sup> (SLB, 2004d) and an average density of 3,802 inhabitants per km<sup>2</sup>. When Greater Berlin was established in 1920 there were 20 administrative units and after the reunification in 1990 there were 23 units (SLB, 2004g). Since 1 January 2001 Berlin is divided in twelve boroughs as listed in table 4.1, where the area, population and density of each borough is presented.

**Table 4.1: Berlin Boroughs**

Number	Borough	Area (km <sup>2</sup> )	Population (million)	Population density (people/km <sup>2</sup> )
01	Mitte	39	0.32	8,231
02	Friedrichshain-Kreuzberg	20	0.26	12,800
03	Pankow	103	0.35	3,379
04	Charlottenburg-Wilmersdorf	65	0.32	4,846
05	Spandau	92	0.23	2,457
06	Steglitz-Zehlendorf	103	0.29	2,796
07	Tempelhof-Schöneberg	53	0.34	6,340
08	Neukölln	45	0.31	6,822
09	Treptow-Köpenick	168	0.23	1,393
10	Marzahn-Hellersdorf	62	0.25	4,081
11	Lichtenberg	52	0.26	4,981
12	Reinickendorf	89	0.25	2,764
<b>TOTAL</b>		<b>891</b>	<b>3.4</b>	<b>3,802</b>

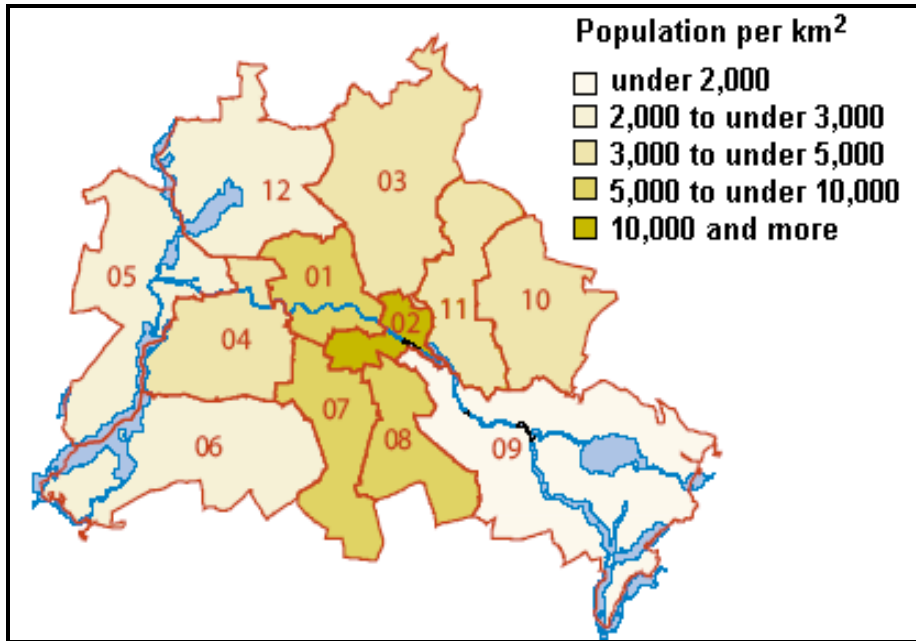
Source: SLB (2004f)

Figure 4.1 shows the population density of the boroughs. The largest borough is *Treptow-Köpenick* (168 km<sup>2</sup>) in the south-east of Berlin, but the northern borough of *Pankow* is where more people live (348,000 persons). The highest density is in the borough of *Friedrichshain-Kreuzberg* (12,800 people/km<sup>2</sup>) near to the centre of the city.

After the reunification of West and East Germany in 1989 Berlin became the capital city of Germany. Berlin's population decreased between the 50s and the 70s and had a strong increase in the 80s (figure 4.2 and table 4.2), reaching its peak of 3,475,000 inhabitants in 1993. Many inhabitants moved into the surrounding countryside after the reunification, but this process declined considerably after 1999 and the population stabilised at 3.39 million (SfS, 2004a). In 2006 the population of Berlin was 3,399,000. No important changes in the total population are expected in the next 10 years, according to the estimations of the body responsible for planning in Berlin, *Senatsverwaltung für Stadtentwicklung* (SfS, 2003 p37).

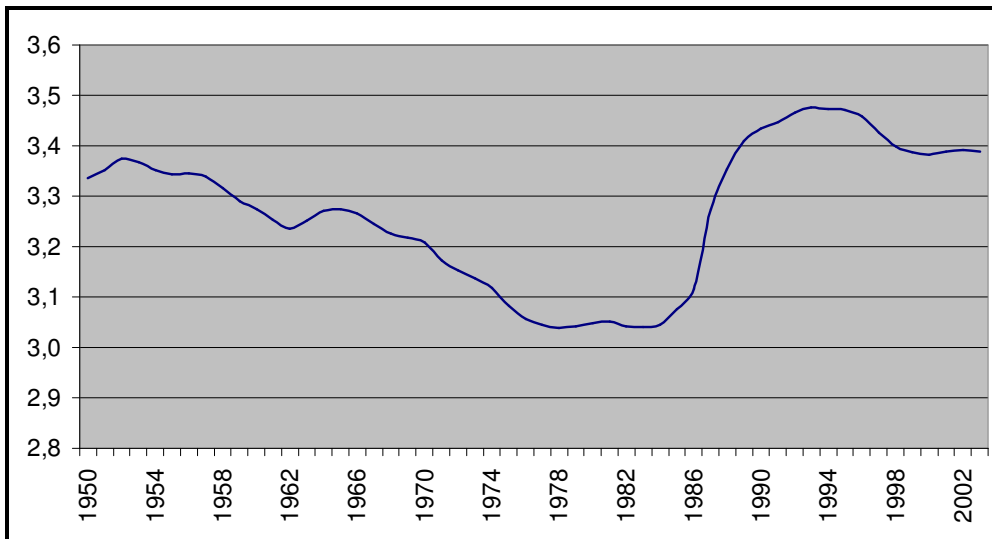
There were 1,884,900 households in Berlin in 2003, 50.1 % were single person households, 30.6 % had 2 people and 19.3 % had 3 or more people. The average family size was only 1.8 people per household (SLB, 2004e p6 (*Statistisches Landesamt Berlin*)).

**Figure 4.1: Berlin Boroughs and Population Density**



Source: SLB (2004f)

**Figure 4.2: Berlin Population between 1950 and 2003 (Million)**



Source: SLB (2004c)

**Table 4.2: Population in Berlin by Gender**

Year	Population (million)	Male (%)	Female (%)
1950	3.34	42.5	57.5
1960	3.27	42.5	57.5
1970	3.21	43.8	56.2
1980	3.05	45.5	54.5
1990	3.43	47.5	52.5
2000	3.38	48.6	51.4
2003	3.39	48.7	51.3
2006	3.40	48.9	51.1

Sources: SLB (2004c, 2006a)

The annual gross domestic product (GDP) in Berlin was € 77,274 million in 2003 (SLB, 2004a). For a population of 3.4 million this implies an annual per capita GDP of € 22,700. Table 4.3 shows the income distribution in Germany in 2003. It can be seen that the richest 20 % of the population (quintile V) receives 39.0 % of the total income, while the poorest fifth receives 7.3 % of it. This means that the richest 20 % have an average income 5.3 times higher than the poorest 20 % of the people.

**Table 4.3: German Income Distribution in Year 2003**

Quintile <sup>(a)</sup>	%
I	7.3
II	12.4
III	17.4
IV	23.9
V	39.0

<sup>(a)</sup> Each quintile is a fifth of the population. Quintile I represents the poorest 20 % of the population, whereas quintile V represents the richest 20 % of the people.

Source: *Institut der deutschen Wirtschaft Köln* (2005 p60)

In 2003 there were 1,505,000 jobs in Berlin (SLB, 2004b). This number has been declining in the last decade (table 4.4). A still unequal distribution of the jobs between West and East Berlin implies that substantially more people in the eastern districts must travel longer distances to their job in the western side of the city (SfS, 2004a).

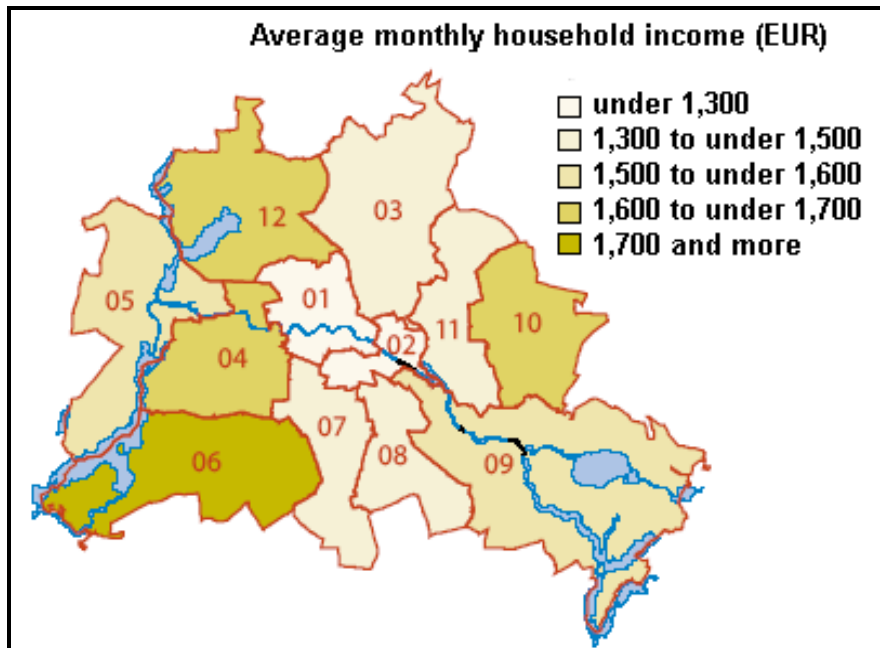
**Table 4.4: Jobs in Berlin**

Year	Jobs (million)
1995	1.61
1997	1.55
1999	1.54
2001	1.55
2003	1.51

Source: SLB (2004b)

After the reunification, eastern Berlin suffered a dramatic economic decline caused by the collapse of the huge state-owned enterprises, the widespread loss of its foreign markets to the east, and the overwhelming productivity advantage enjoyed by West German industry. But the situation in western Berlin in 1990 was also dramatic. There was a large shift in industrial potential, particularly acute in the manufacturing sector, as subsidies that had supported West Berlin's industry dried up and producers began relocating their factories outside the city limits. All these factors combined provoked a high loss of jobs in the manufacturing and trade sectors. This negative trend could only be slightly offset by the steady increase in the city's travel and tourism industry or by the all too hesitant growth experienced in the service sectors (SLB, 2000).

Figure 4.3 shows the average monthly income of the households. It can be seen that the highest incomes are found in some peripheral boroughs. The highest average household incomes are in the boroughs of *Steglitz-Zehlendorf* (6) and *Marzahn-Hellersdorf* (10), whereas the lowest are in *Friedrichshain-Kreuzberg* (2) and *Mitte* (1), as shown in table 4.5.

**Figure 4.3: Average Monthly Household Income in the Boroughs of Berlin**

Source: SLB (2004g)

**Table 4.5: Income and Motorisation Rate in the Boroughs of Berlin**

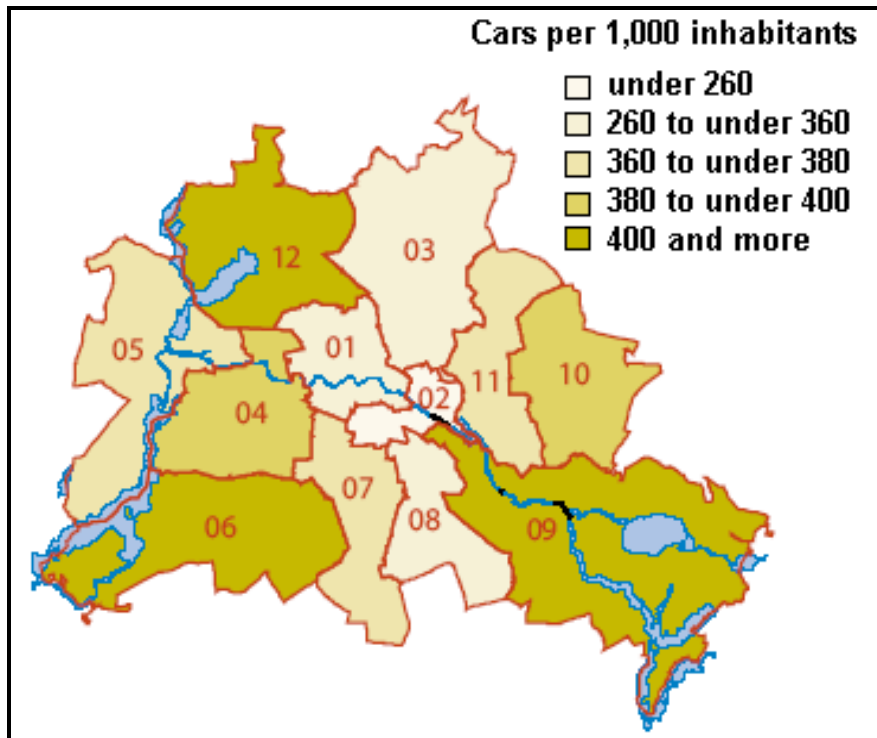
Borough	Average monthly household Income (€)	Motorisation rate (cars per 1,000 inhabitants)
01 Mitte	1,275	292
02 Friedrichshain-Kreuzberg	1,225	259
03 Pankow	1,375	355
04 Charlottenburg-Wilmersdorf	1,600	391
05 Spandau	1,575	376
06 Steglitz-Zehlendorf	1,875	425
07 Tempelhof-Schöneberg	1,475	379
08 Neukölln	1,375	320
09 Treptow-Köpenick	1,575	406
10 Marzahn-Hellersdorf	1,675	385
11 Lichtenberg	1,475	364
12 Reinickendorf	1,600	419
<b>BERLIN</b>	<b>1,475</b>	<b>365</b>

Source: SLB (2004g), data for year 2000

Regarding the motorisation rate, the highest numbers are also found in some of the peripheral boroughs (figure 4.4), especially in *Steglitz-Zehlendorf* (6), *Reinickendorf* (12) and *Treptow-Köpenick* (9). The lowest numbers of cars per inhabitant are found in *Friedrichshain-Kreuzberg* (2) and *Mitte* (1), as shown in table 4.5.

The average motorisation rate in Berlin has remained very stable over the last years. Between 1993 and 2002 it increased by less than 4 % (SfS, 2004e). Two different values were found for the motorisation rate in 2002. SLB (2004g) reports 365 cars per 1,000 inhabitants, while SfS (2004e) informs about 329 cars (including vans) per 1,000 inhabitants.

Figure 4.4: Motorisation Rate in the Boroughs of Berlin



Source: SLB (2004g)

## 4.2 Modal Split and Generation Rates

On an average day (including weekdays and weekends) 3.05 trips were made by each person in Berlin in 1998 (SfS, 2004b). If only weekdays are considered, each person travelled 3.31 times on average. Assuming that these figures remained stable, in 2003 a total of 10.2 million trips were made on an average day and 11.1 million on a typical weekday.

More trips are made by car than public transport in Berlin (table 4.6). Moreover, the difference between both has risen between 1992 and 1998. Although the bicycle has the lowest modal split of the four modes presented, it has an important and increasing proportion in the total trips.

Table 4.6: Modal Split Evolution in Berlin

Mode	1992 (%)	1998 (%)
Public transport	31	27
Car	35	38
Walking	27	25
Bicycle	7	10
<b>TOTAL</b>	<b>100</b>	<b>100</b>

Source: SfS (2004c)

The public transport modal split is presented in table 4.7. Underground and bus are the most important public transport modes in Berlin, in terms of trip-stages. Nevertheless, the suburban rail (*S-Bahn*) has increased its modal split between 1994 and 2002. The rise in the

trip-stages made in the *S-Bahn* (22.5 % between 1994 and 2002) is mostly explained by the development of its network, which grew by 21.9 % during the same years and an impressive 40.0 % between 1990 and 2002 (see table 4.24 below).

**Table 4.7: Public Transport Modal Split in Berlin**

Mode	1994		2002	
	Trip-stages (million/year)	%	Trip-stages (million/year)	%
Underground	455.3	35.2	399.2	33.0
Bus	436.1	33.8	361.3	29.9
Tram	151.7	11.7	142.5	11.8
Suburban rail <i>S-Bahn</i>	249.0	19.3	305.0	25.2
<b>TOTAL</b>	<b>1,292.1</b>	<b>100.0</b>	<b>1,208.0</b>	<b>100.0</b>

Source: SLB (2003)

Table 4.8 shows that the total trip generation rate is higher in the case of men than in the case of women. Nevertheless, females travel more in public transport than men (0.88 trips per day against 0.67).

**Table 4.8: Trip Generation Rates by Gender in Berlin in 1998**

Gender	Public transport (trips/day)	Other modes (trips/day)	TOTAL (trips/day)
Male	0.67	2.68	3.35
Female	0.88	2.41	3.29

Source: SfS (2004b)

In table 4.9 trip generation rates divided by age are shown. People under 44 years make more trips per day and also more public transport trips. Even so the highest proportion of trips by public transport is for those over 64 years, followed by the younger people (6 to 18 years) as shown in table 4.10.

**Table 4.9: Trip Generation Rates by Age in Berlin in 1998**

Age range	Public transport (trips/day)	Other modes (trips/day)	TOTAL (trips/day)
6 to 18 years	0.84	2.57	3.41
18 to 44 years	0.81	2.92	3.73
44 to 64 years	0.72	2.47	3.19
Over 64 years	0.73	1.56	2.29

Source: SfS (2004b)

Table 4.11 shows the trip generation rates divided by the main activity of the person. The highest trip generation rates are found in the case of university students and part-time workers. When only public transport trips are considered, the highest generation rates are for university students, followed by school students and part-time workers. Regarding modal split, table 4.12 shows that the highest proportion of trips in public transport is found in the case of pensioners, followed by university students, unemployed and school students.

**Table 4.10: Public Transport Modal Split by Age in Berlin in 1998**

Age range	Public transport (%)	Other modes (%)	TOTAL (%)
6 to 18 years	24.6	75.4	100.0
18 to 44 years	21.7	78.3	100.0
44 to 64 years	22.6	77.4	100.0
Over 64 years	31.9	68.1	100.0

Source: Own calculations based on data from SfS (2004b)

**Table 4.11: Trip Generation Rates by Main Activity in Berlin in 1998**

Age range	Public transport (trips/day)	Other modes (trips/day)	TOTAL (trips/day)
School student	0.93	2.57	3.50
University student	1.27	3.16	4.43
Part-time worker	0.92	3.16	4.08
Full-time worker	0.66	2.84	3.50
Unemployed	0.88	2.32	3.20
Pensioner	0.73	1.75	2.48
House-wife/husband	0.59	2.54	3.13

Source: SfS (2004b)

**Table 4.12: Trip Generation Rates by Main Activity in Berlin in 1998**

Age range	Public transport (%)	Other modes (%)	TOTAL (%)
School student	26.6	73.4	100.0
University student	28.7	71.3	100.0
Part-time worker	22.5	77.5	100.0
Full-time worker	18.9	81.1	100.0
Unemployed	27.5	72.5	100.0
Pensioner	29.4	70.6	100.0
House-wife/husband	18.8	81.2	100.0

Source: Own calculations based on data from SfS (2004b)

Some differences could be recognised in the trip generation rates in Berlin in 1998, when comparing the figures for the west and east boroughs (formerly West and East Berlin). In fact, the west boroughs had a slightly higher generation rate of total trips (table 4.13). In addition, the east boroughs made a higher proportion of trips on public transport. But as the city becomes more homogeneous, these differences will surely tend to disappear.

**Table 4.13: Trip Generation Rates in Western and Eastern Berlin in 1998**

Zone	Public transport (trips/day)	Other modes (trips/day)	TOTAL (trips/day)
West boroughs	0.89	2.41	3.30
East boroughs	0.98	2.28	3.26

Source: SfS (2004b)

### 4.3 Purpose, Length and Speed of the Trips

Table 4.14 presents the main purposes of the trips in Berlin in 1998. It can be seen that work, business and study trips account for only 42.3 % of the total trips. On the other hand, leisure is one of the most important purposes of trips.

**Table 4.14: Trips Purpose in Berlin in 1998**

Trip purpose	%
Work	23.8
Business	7.0
Study	11.5
Purchase	20.3
Leisure	22.5
Other	14.8
<b>TOTAL</b>	<b>100</b>

Source: SfS (2004c)

The length of public transport trips is presented in table 4.15. 40 % of these trips are less than 5 km long and 30 % are longer than 10 km.

**Table 4.15: Trip Length Distribution in the Public Transport in Berlin in 1998**

Trip length	%
Less than 1 km	5
1 to 3 km	19
3 to 5 km	16
5 to 10 km	30
10 to 15 km	17
15 to 20 km	8
Over 20 km	5
<b>TOTAL</b>	<b>100</b>

Source: SfS (2004d)

In table 4.16 the average commercial speeds of different public transport modes are presented. Not surprisingly, the underground has a higher commercial speed than bus and tram (50 % higher).

**Table 4.16: Public Transport Average Speeds in Berlin in 2005**

Transport mode	Commercial speed (km/h)
Underground	31.1
Bus	19.6
Tram	19.3

Source: BVG (2006d)



## 4.4 Organisation of the Public Transport System

There are two main public transport operators in Berlin: the *Berliner Verkehrsbetriebe* (BVG) and the *S-Bahn Berlin GmbH* (S-Bahn).

The **BVG** operates 151 bus lines, 9 underground lines, 22 tram lines and 6 ferry services. It is a public company owned by the city of Berlin (BVG, 2004b). After a peak of more than 1,000 million passengers in 1993, the patronage of the BVG declined until 1997, when 789 million passengers were moved. The demand has been growing thereafter, reaching 907 million in 2005 (figure 4.5 and table 4.17). The occupation factor of the BVG vehicles increased from 15.8 % in 2000 to 17.6 % in 2005 (BVG, 2006e p25).

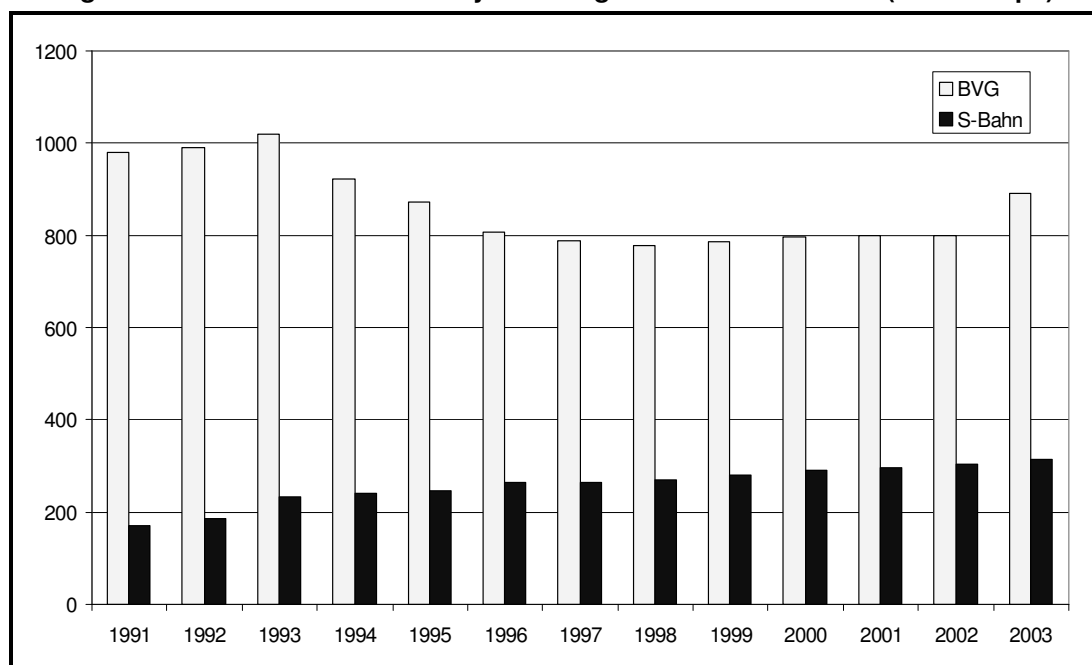
**Table 4.17: Yearly Patronage of the BVG**

Year	Passengers (million)
1993	1,020
1997	789
2002	799
2005	907

Sources: Sfs (2004m) and BVG (2004a, 2006d)

The **S-Bahn** is owned by the *DB Regio AG*, which is part of the *Deutsche Bahn AG*, the former German public train operator, who began a long privatisation process in 1994. It operates 16 suburban rail lines and has had a continuously growing yearly patronage in the last years (table 4.18 and figure 4.5).

**Figure 4.5: Evolution of the Yearly Patronage of BVG and S-Bahn (million trips)**



Source: Sfs (2004m), BVG (2004a) and SBB (2004b)

After the wall came down, Berlin and the surrounding federal state (*Bundesland*) of Brandenburg (figure 4.6) were interested in handling the aspects of public transport together, in order to reconnect Berlin to its hinterland. Thus in 1996 the **Verkehrsverbund**

**Berlin-Brandenburg (VBB)** was founded. More details about the *Verkehrsverbund* are given in chapter 7.

**Table 4.18: Yearly Patronage of the S-Bahn**

Year	Passengers (million)
1991	171
1995	245
1999	280
2003	315
2005	357

Sources: Sfs (2004m) and SBB (2004b, 2006)

**Figure 4.6: German Federal States: Brandenburg and Berlin**



## 4.5 Car Travel

There are 5,300 km of public streets and almost 2,000 traffic signals in Berlin (SfS, 2004h). In 2002 there were 45 park and ride facilities in Berlin, with a total of 5,393 parking spaces (SfS, 2004g). This implies that park and rides provide space for about 0.5 % of the cars of Berlin. The different sizes of these park and rides are shown in table 4.19.

**Table 4.19: Park and Ride Facilities in Berlin in 2002**

Size (places)	Number
Under 100	25
100 to 200	14
Over 200	6
<b>TOTAL</b>	<b>45</b>

Source: SfS (2004g)

The number of licensed taxis decreased in the last decade in Berlin (table 4.20). It can be seen that 6,800 licensed taxis existed in 2002.

**Table 4.20: Taxis in Berlin**

Year	Licensed taxis
1993	7,200
1997	6,800
2002	6,800

Source: SfS (2004f)

## 4.6 The Underground, Tram and Suburban Rail Systems

The first **underground (U-Bahn)** ran in Berlin in 1902 (BVG, 2004i). The underground network expanded then continuously until the division of the city, which impacted the underground service. In 1961, after the construction of the wall, some underground lines were interrupted (BVG, 2006b). The underground station *Friedrichstrasse* in East Berlin became a frontier crossing point between East and West Berlin. Most parts of the underground network were in West Berlin, and the majority of the expansions was made in that part of the city until 1989, when the wall fell. Table 4.21 shows the evolution of the underground system in Berlin in the 1990s, both in terms of network length and number of stations.

**Table 4.21: Evolution of the Underground System in Berlin**

Year	Network length (km)
1923	42
1930	76
1956	78
1963	89
1972	103
1978	112
1984	121
1990	135
1998	143
2005	144

Sources: SfS (2004l), Berliner-Untergrundbahn.de (2006)

In 2005 Berlin had 9 underground lines with a total length of 144 km. There were 170 underground stations with an average distance of 790 m between each other, 1,368 vehicles (850 wide gauge and 518 narrow gauge) and 6 depots and workshops. 458 million passenger journeys were made and the average commercial speed of the underground system in Berlin was 31.1 km/h (BVG, 2004a, 2006c).

The first electric **tram** of the world ran near Berlin in the year 1881 and the first electric tram service in the city was inaugurated in 1895. After the division of Berlin the west side closed its tram lines after 1954. The last tramways ran in West Berlin in 1967. In contrast, East Berlin preserved and developed the tram services. Therefore, a decade after the reunification almost all tram lines are still in the east side of the city. Table 4.22 shows the growth of the tramway network in Berlin after 1990.

**Table 4.22: Evolution of the Tramway System in Berlin**

Year	Network length (km)
1990	173.6
1994	176.8
1998	181.6
2005	187.7

Sources: SfS (2004I), BVG (2006d)

Berlin had 22 lines of tramways running on a 188 km long network in 2005. 108 km (57.5 %) of this network were segregated from the rest of the traffic. There were 373 stations with an average distance of 461 m, 600 vehicles and 11 depots and workshops. The average commercial speed of the trams was 19.3 km/h. The number of journeys in 2005 was estimated to be 167 million (BVG, 2006d).

In addition, there were 16 **Suburban Rail (S-Bahn)** lines operating a 331 km length network in Berlin in 2005 (SBB, 2006). There were 165 *S-Bahn* stations, yielding an average distance of 2 km. The *S-Bahn* had 733 vehicles and 3 depots and workshops. The average age of the vehicles fell drastically from 43.6 years in 1995 to only 6.1 years in 2003 (table 4.23). The yearly patronage of the *S-Bahn* has been continuously rising between 1991 and 2005, reaching 357 million passenger journeys, as shown in table 4.18 (SBB, 2004a, 2006).

**Table 4.23: Average Age of the S-Bahn Fleet**

Year	Average age
1995	43.6
1999	27.2
2003	6.1
2005	7.2

Source: SBB (2004b, 2006)

Table 4.24 shows the impressive evolution of the rail system in Berlin after 1990, both in terms of network length and number of stations.

**Table 4.24: Evolution of the S-Bahn System in Berlin**

Year	Network length (km)	S-Bahn stations
1990	182.4	91
1994	209.5	115
1998	249.0	129
2002	255.3	132
2005	331.0	165

Sources: SfS (2004I), SBB (2006)

## 4.7 Bus System

Berlin had 151 bus lines with a total length of 1,662 and 2,611 stops (6,579 stops if divided by direction) in 2005. The average distance between stops was 480 m. There were 1,328 buses, all of them operated by the municipal *Berliner Verkehrsbetriebe*, which has 15 depots

and workshops for the buses. In one year 404 million passenger journeys were made. The average commercial speed of the buses in Berlin was 19.6 km/h in 2005. The express buses had a higher average commercial speed of 22.3 km/h (BVG, 2006d). More than 100 km of bus lanes existed in Berlin in 2005. Table 4.25 shows the impressive growth of the bus lanes network in Berlin in the 1990s.

Regarding the vehicles, in 2005 there were 357 double-deck buses (used in London and Berlin, but not generally common in big cities because of its capacity and boarding/alighting difficulties given by the small number of doors), 459 articulated buses, 395 simple (one-deck, no-articulated) buses and 117 special vehicles (BVG, 2006d). In February 2004 a total of 25 new very clean diesel buses were introduced. These already fulfil the Euro 5 norm, which will not be an obligation until 2008 (BVG, 2004e). On the other hand, in April 2004 one hydrogen-powered bus was put experimentally in operation (BVG, 2004f).

**Table 4.25: Evolution of the Bus Lanes in Berlin**

Year	Bus lanes (km)
1990	33.8
1994	67.1
1998	94.4
2002	101.5
2005	101.9

Source: SfS (2004l)

## 4.8 Recent Changes in the Public Transport System: MetroLines

In December 2004 a new concept was introduced in the public transport of Berlin. Under the name of "MetroLines" 15 main bus lines and 9 main tram lines which run in corridors where no underground or *S-Bahn* exist began to operate under the following conditions (BVG, 2004g; BVG, 2004h):

- at least 20 hours of operation daily, weekdays and at weekends,
- high frequencies to avoid that passengers need to memorise the schedule, at least every 10 minutes,
- MetroBus lines and MetroTram lines are identified with an M before the number of the service.

The MetroLines supplement the existing underground and S-Bahn services, allowing 87 % of the population to live and work in the proximity of the core of the new system. The rest of the bus and tram lines continued their services with lower frequencies and shorter operation hours. Nevertheless, only 0.1 % of the passengers were affected by the service reductions, while 3.9 % benefited from the service expansions (BVG, 2004g).

MetroLines were introduced in some corridors with a high number of car trips and low public transport modal split, in order to improve the service there and attract more users to the public transport (BVG, 2004g). An important objective of the changes is to provide an easier-to-understand public transport system. Therefore, new maps for the underground (*U-Bahn*), *S-Bahn* and MetroLines were designed (BVG, 2004h).

In May 2006 the MetroLines began a 24-hours operation, with 10 minutes headways at least until 21:00. There were 17 MetroBus lines and 9 MetroTram lines in operation (BVG, 2006a).

We will analyse the public transport fare system and the financial aspects of public transport in Berlin in chapter 8. In the following chapter, the transport system of Madrid is analysed.

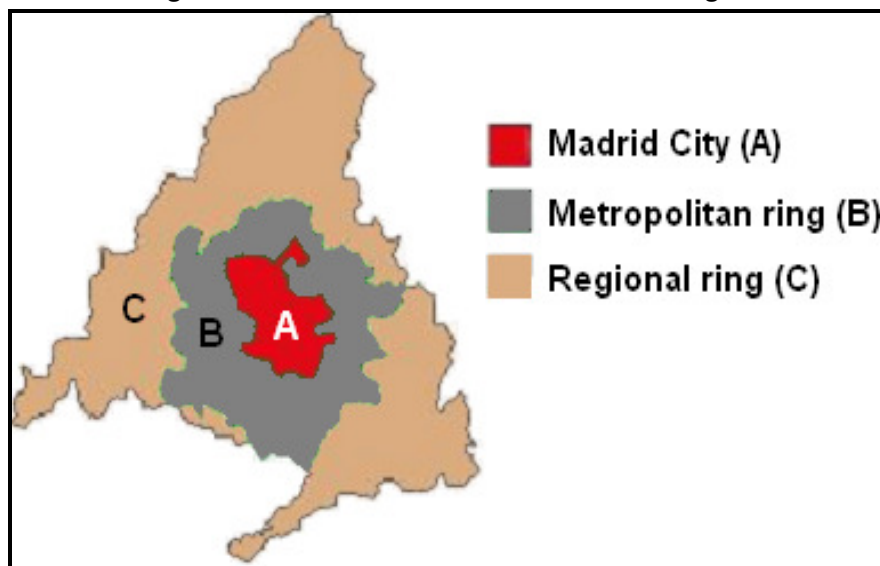
## 5. Analysis of Madrid and its Transport System

### 5.1 Socio-economic Description

Madrid is the name of both the capital city of Spain and its region. Madrid Region (*Comunidad de Madrid*) is formed by 179 municipalities, Madrid City being one of them. The organisation and location of population, activities and socio-economic features in Madrid Region show a well-defined functional structure, as can be recognised in figure 5.1:

- A) Madrid City is the main municipality of the region and concentrates the economic activities;
- B) the Madrid metropolitan ring consists of a number of large and medium size entities around the municipality of Madrid and has strong relations with the central city;
- C) the rest of the region has small and medium size municipalities.

Figure 5.1: Territorial Structure of Madrid Region



Source: Cristóbal-Pinto (2002)

The population, surface and density of the three zones defined in figure 5.1 are presented in table 5.1. The population of Madrid City (A) is more than ten times the population of the rest of the region (C), while the area of the latter is more than eight times the surface of the former. So, the population density in Madrid City is 100 times higher than the density in the rest of the region (C).

Table 5.1: Population, Area and Density in Madrid Region in 1996

Zone	Population	Area (km <sup>2</sup> )	Density (inhab/km <sup>2</sup> )
Madrid City (A)	2,866,850	606.4	4,727.7
- Central Core	915,318	42.0	21,793.3
- Rest of the City	1,951,532	564.4	3,457.7
Metropolitan area (B)	1,913,804	2,280.7	839.1
Rest of the region (C)	241,636	5,141.4	47.1
<b>TOTAL REGION</b>	<b>5,022,289</b>	<b>8,028.5</b>	<b>625.6</b>

Source: Cristóbal-Pinto (2002)

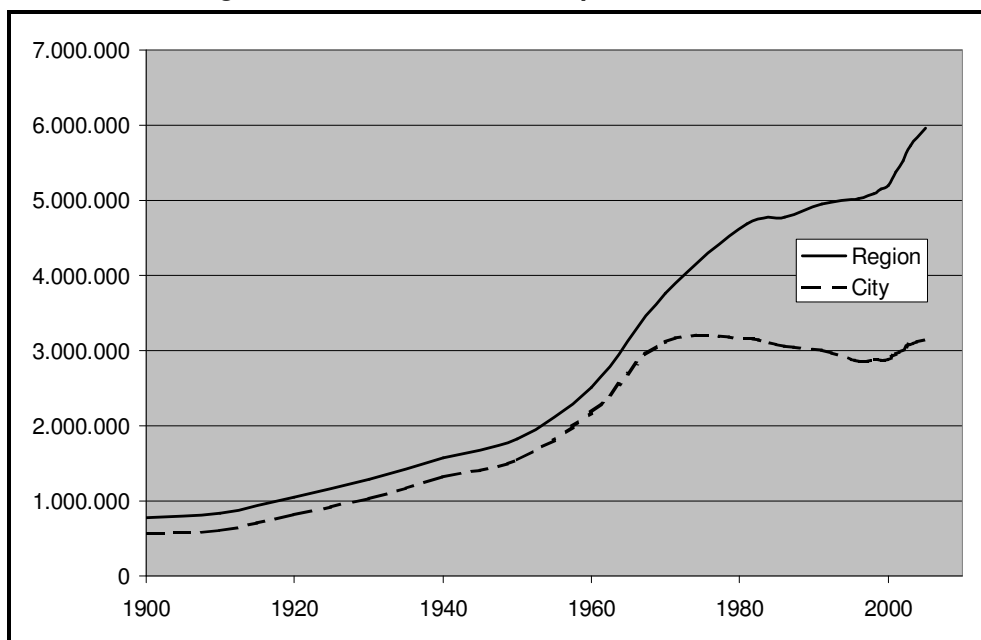
The population in Madrid Region has been continuously rising in the last century, reaching almost 6 million in 2005 (table 5.2 and figure 5.2). The statistics institute of Madrid Region projects that the population will continue growing, reaching 6.5 million in 2012 (IECM, 2004b). On the other hand, the city of Madrid incremented its population until the 1970s and afterwards remained more or less constant between 3.0 and 3.1 million, as can be seen in table 5.2 and figure 5.2. Thus, a process of suburbanisation can be recognised in Madrid in the last decades (Matas, 2004). The population of the city of Madrid is projected to rise slowly in the future, reaching 3.3 million in 2014 (IECM, 2004b).

**Table 5.2: Evolution of the Population in Madrid**

Year	City population (million)	Region population (million)
1900	0.58	0.78
1910	0.61	0.88
1920	0.82	1.07
1930	1.04	1.38
1940	1.32	1.58
1950	1.55	1.93
1960	2.18	2.60
1970	3.12	3.76
1981	3.16	4.69
1991	3.01	4.95
2001	2.96	5.37
2003	3.09	5.72
2005	3.16	5.96

Sources: IECM (2004a, 2006a)

**Figure 5.2: Evolution of the Population in Madrid**

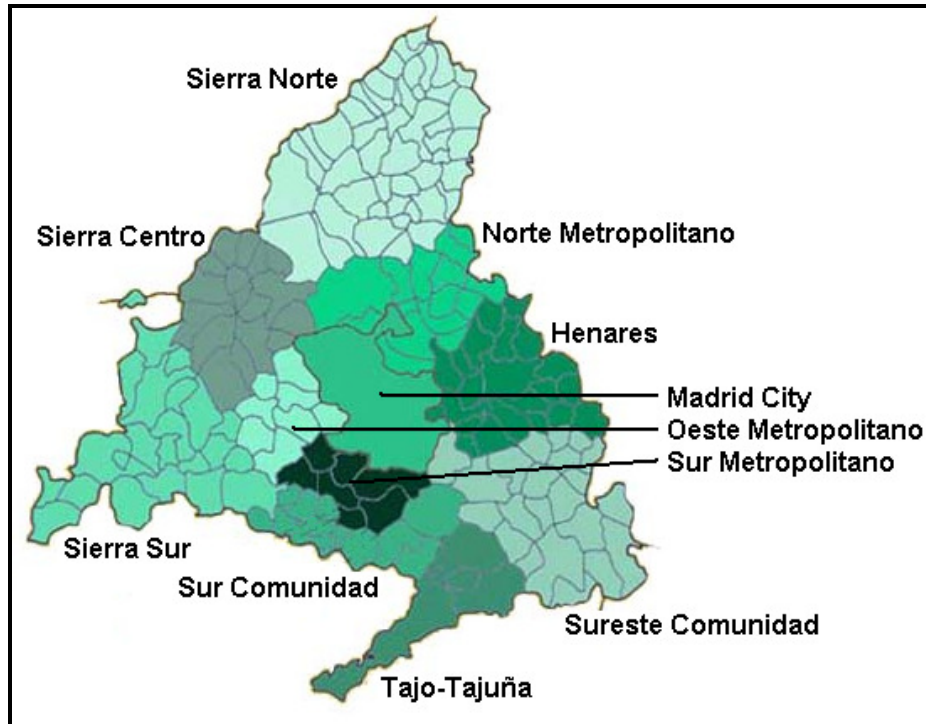


Source: IECM (2004a)

Figure 5.3 shows a typical aggregation of the 179 municipalities of Madrid Region into 11 zones.

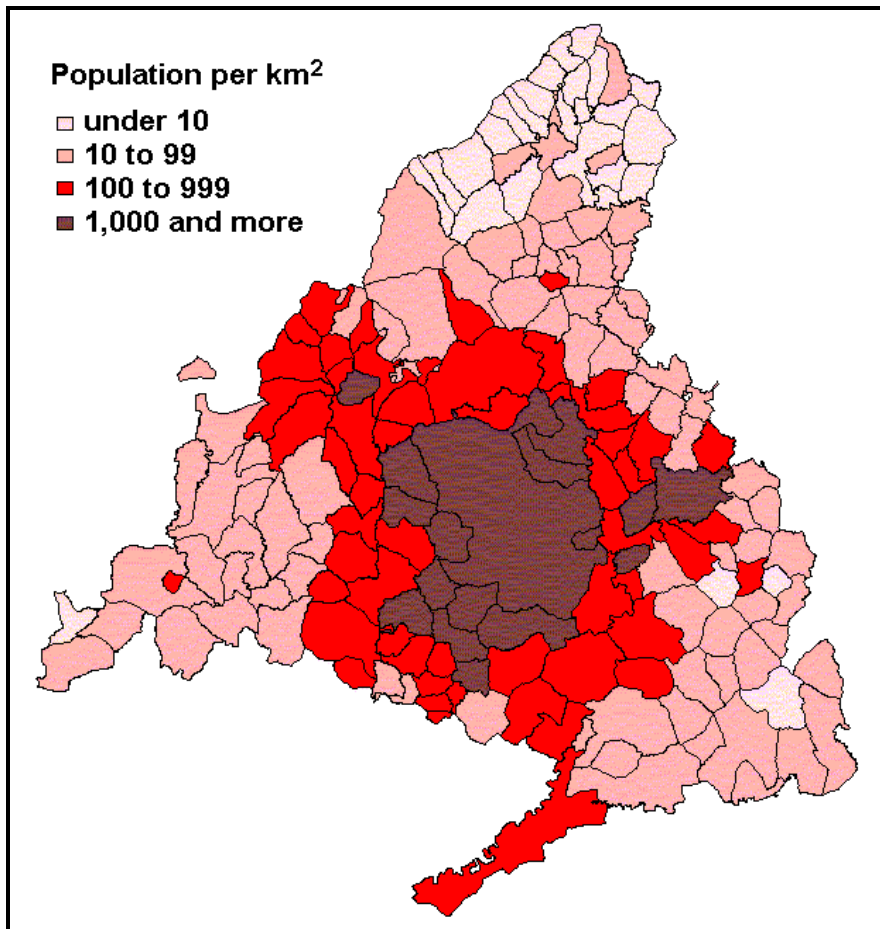


Figure 5.3: Madrid Region in 11 Zones



Source: Pinto (2004)

Figure 5.4: Population Density in Madrid Region in 2002

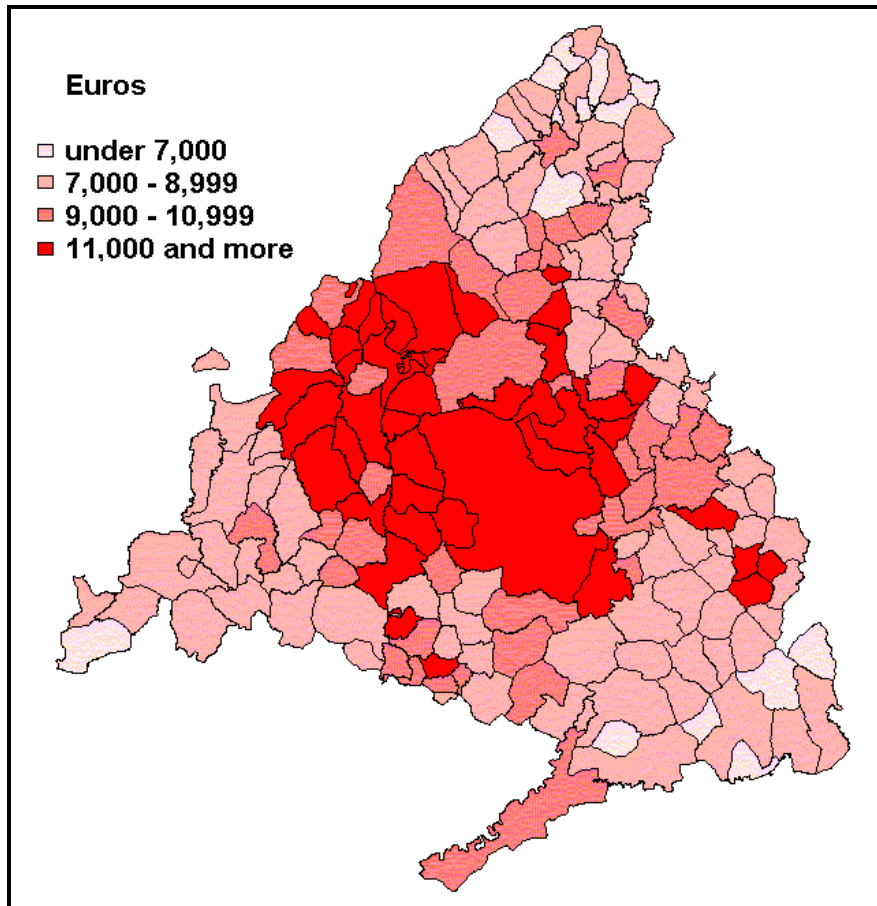


Source: IECM (2004d)

In 2005 the average population density of Madrid Region was 750 inhabitants per km<sup>2</sup>. Figure 5.4 shows the population density in the municipalities of Madrid Region. It can be seen that the higher densities are found in Madrid City and its surrounding municipalities. The lower densities are in the north of the region (*Sierra Norte*), followed by the south-east (*Sureste Comunidad*) and the west (*Sierra Sur*). The population density in Madrid City was 5,280 inhabitants per km<sup>2</sup> in 2005.

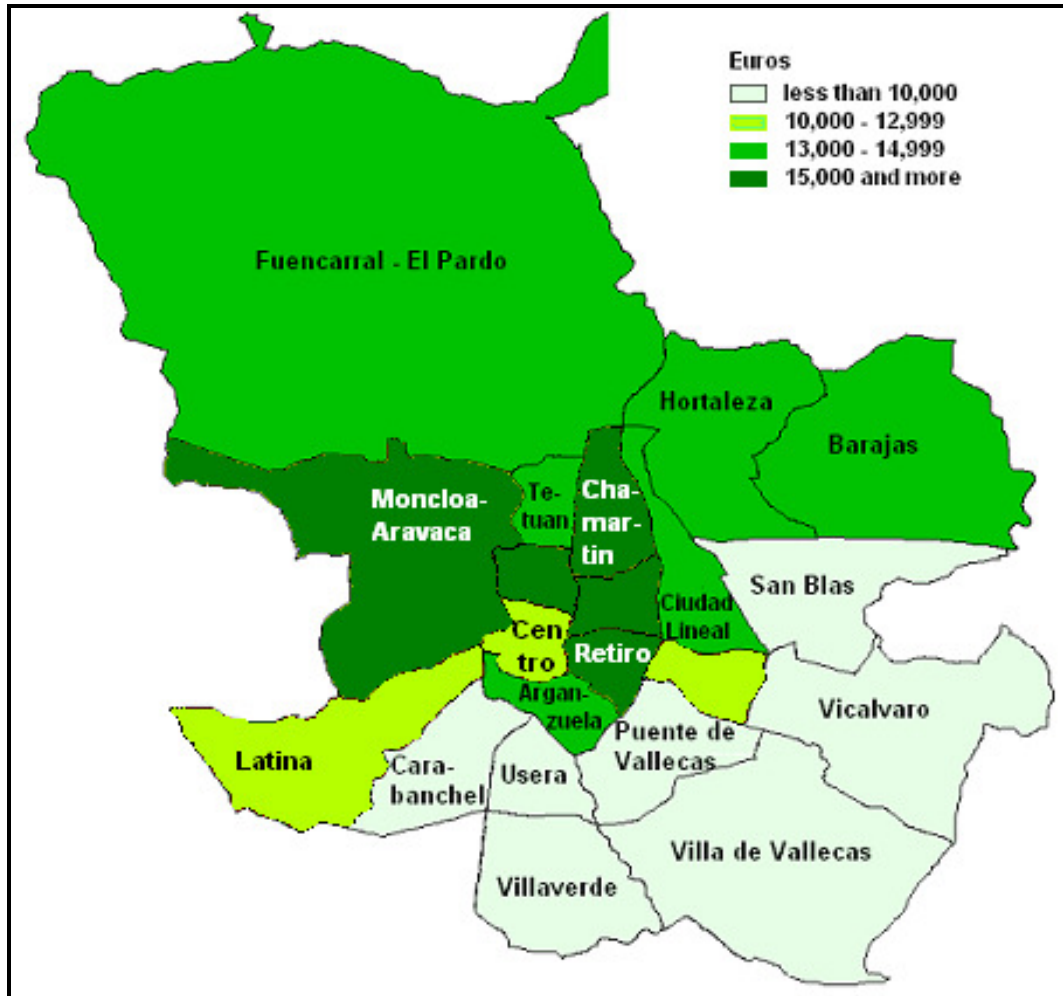
The annual per capita gross domestic product (GDP) in Madrid was US\$ 22,800 in 2002 (EMTA, 2004a p65). Madrid has 13 % of the population of Spain and it accounts for 18 % of the GDP of the country. Madrid City and some municipalities near it in the north and west have the highest per capita income of the region (figure 5.5). The poorest municipalities are in the north (*Sierra Norte*), south-west (*Sierra Sur*) and south-east (*Sureste Comunidad*) extremes of Madrid Region.

**Figure 5.5: Gross Disposable Income per Capita in Madrid Region in 2000**



Source: IECM (2004d)

The distribution of the income inside Madrid City (figure 5.6) shows that the higher income districts are near the centre of the city, both in the north-west and the north-east. On the other hand, the lower income districts are mainly in the south and south-east of the city.

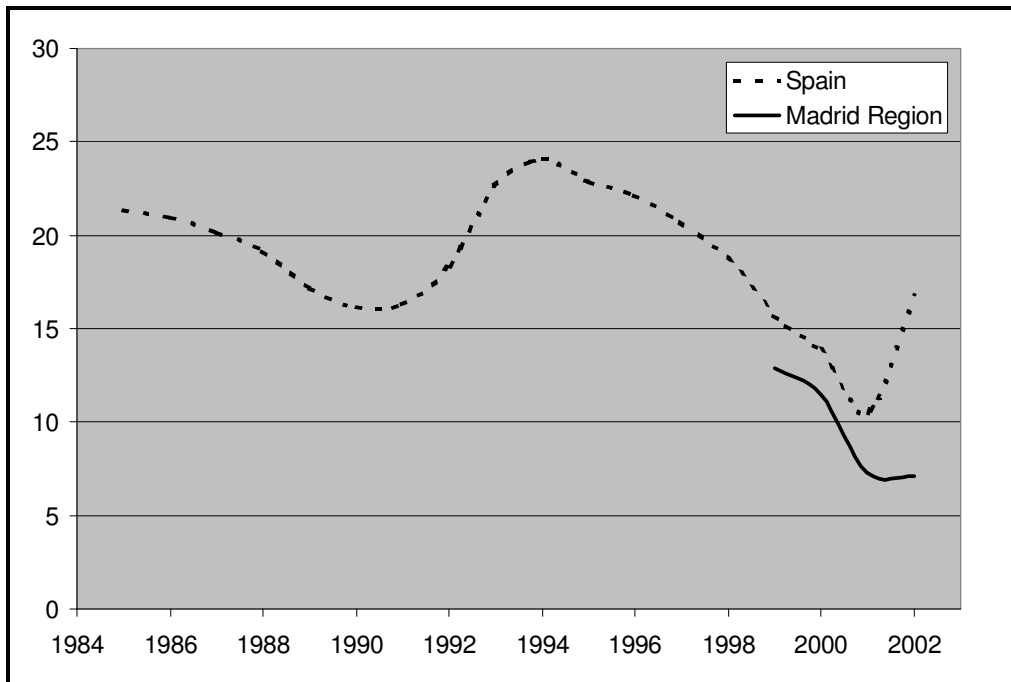
**Figure 5.6: Gross Disposable Income per Capita in Madrid City in 2000**

Source: Ayuntamiento de Madrid (2006a)

In relation with the income distribution in the entire country, statistics of the United Nations show that the richest 20 % of the Spanish population have an income 5.4 times higher than the poorest 20 % of the people in Spain (UNDP, 2005a).

There were 2.25 million jobs in 2001 in Madrid Region (EMTA, 2004a p65). Given that the employment structure is dominated by the service sector, which accounts for 75 % of the total amount of jobs (of which 35 % are in the public sector), jobs have remained heavily centralised in Madrid City (Matas, 2004 p196). Basing on different estimations, Matas reports that around 70 % of the jobs are in the city and most of them in the city centre. Therefore, the urban structure of Madrid predominantly follows a monocentric model with radial trips from satellite settlements to the city centre.

The general unemployment rate in Madrid Region is lower than in Spain (figure 5.7). In 2002, the unemployment rate in Spain was 16.7 %, much higher than the 7.1 % in Madrid (IECM, 2004c).

**Figure 5.7: Evolution of the Unemployment Rate in Madrid and Spain (%)**

Source: IECM (2004c)

The unemployment rate in Madrid has fallen between 1999 and 2002 (table 5.3). It is interesting to note that it is much higher for women than for men and that it is dramatically higher in the case of young people, especially those between 16 and 19 years.

**Table 5.3: Unemployment Rate in Madrid Region**

Population group	1999 (%)	2002 (%)
Men	9.3	4.8
Women	18.2	10.3
16 to 19 years old	35.4	20.7
20 to 24 years old	23.0	13.7
<b>Total</b>	<b>12.9</b>	<b>7.1</b>

Source: IECM (2004c)

The motorisation rate in Madrid Region increased by 85 % between 1986 and 2002, reaching 550 cars per 1,000 inhabitants in 2002 (table 5.4). In the same year, Madrid City had 1.7 million cars and 546 cars per 1,000 inhabitants (IECM, 2004e).

**Table 5.4: Cars and Motorisation Rate in Madrid Region**

Year	Cars (million)	Cars per 1,000 inhab.
1986	1.4	298
1991	1.9	387
1996	2.3	464
2001	2.9	547
2002	3.0	550

Sources: IECM (2004e, 2004f)

## 5.2 Modal Split and Public Transport Demand

According to Madrid's mobility study of 1996 (Cristóbal-Pinto, 2002), 10.6 million trips were made in Madrid Region on a typical weekday (2,1 trips per inhabitant). In 2002 the number of trips per person per day had slightly increased to 2,2 (EMTA, 2004b). Table 5.5 shows the evolution of the modal split in Madrid Region, between 1981 and 1996. It can be seen that the modal split of the car increased strongly in that period. Meanwhile, the walking trips reduced their proportion from 57.7 % to 37.2 %. In 1996 the modal splits of public transport, private vehicle and walking were all close to one third.

**Table 5.5: Evolution of the Modal Split in Madrid Region**

Transport mode	1981 (%)	1988 (%)	1996 (%)
Public transport	28.9	27.4	33.3
Private vehicle	13.6	20.4	29.5
Walking	57.7	47.7	37.2

Sources: Cristóbal-Pinto (2002) and Sanz-Alduán (1999)

Considering only motorised trips in Madrid Region, the modal split of public transport was 54 %, in comparison to 46 % of the private vehicle. For inner trips within Madrid City the use of public transport (66 %) is much higher than the use of the private vehicle (34 %). On the contrary, in the metropolitan ring the use of the car is predominant, with a modal split of 70 % versus 30 % for the public transport. Considering the trips between the metropolitan ring and Madrid City, the distribution is almost equal: public transport 52 % and private vehicle 48 % (Cristóbal-Pinto, 2002).

There are four public transport modes in Madrid Region. Two of them operate mainly in Madrid City (metro and urban bus) and the other two operate mainly in the rest of the region (suburban bus and suburban rail). Table 5.6 presents the distribution of the public transport trips between those modes, both in terms of number of passengers and passenger-km. Considering passenger trips, urban public transport modes account for 69 % of the modal split. On the contrary, when passenger-km are considered, suburban public transport modes account for the highest part of the modal split: 62 %. This difference is explained by the longer distances travelled by the suburban passengers.

**Table 5.6: Public Transport Modal Split in Madrid Region in 2002**

Public transport mode	Passengers		Passenger-km	
	(million)	(%)	(million)	(%)
Metro	563.8	37	3,156	25
Urban bus	478.4	32	1,674	13
Suburban bus	277.8	18	4,403	35
Suburban rail	193.7	13	3,458	27
<b>TOTAL</b>	<b>1,513.7</b>	<b>100</b>	<b>12,691</b>	<b>100</b>

Source: EMTA (2004a)

In table 5.7 the evolution of the public transport modal split between 1998 and 2003 is presented. Metro increased its modal split due to important extensions in its network, while the urban bus share declined. On the other hand, it can be seen that the suburban modes increased their modal split, while the urban public transport modes decreased it (metro +

urban bus). This is explained by the suburbanisation process in Madrid Region discussed above.

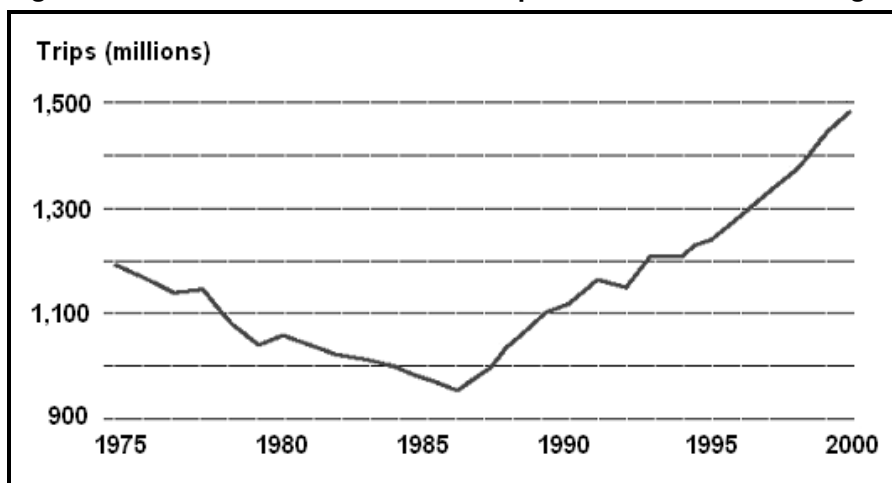
**Table 5.7: Evolution of the Public Transport Modal Split in Madrid**

Public transport mode	1998		2004	
	Passengers (million)	%	Passengers (million)	%
Metro	437.0	32	618.4	40
Urban bus	547.7	40	473.7	30
Suburban bus	236.6	17	276.2	18
Suburban rail	143.5	11	195.9	12
<b>TOTAL</b>	<b>1,364.8</b>	<b>100</b>	<b>1,564.2</b>	<b>100</b>

Sources: IECM (2004e, 2006b)

Between 1975 and 1985 the total public transport demand decreased by circa 20 % (figure 5.8), in spite of an important extension of the metro network in the same period. Cristóbal-Pinto (2002) argues that the main reasons for this reduction were the lack of operational and fare integration between the different operators, and some socio-economic tendencies like suburbanisation and income (and motorisation) increases.

**Figure 5.8: Evolution of the Public Transport Demand in Madrid Region**



Source: Cristóbal-Pinto (2002)

In contrast, between 1986 and 2000 the public transport demand increased by almost 50 %. The reasons for this impressive change seem to be the creation of a Regional Transport Authority (*Consortio Regional de Transportes de Madrid*) together with the implementation of measures of modal and fare integration. In terms of fare integration, the creation of a travel pass (*Abono Transportes*), which is presently used in more than 60% of public transport trips, is mentioned as one of the key issues (Cristóbal-Pinto, 2002; Matas, 2004). On the other hand, the policy of strong extensions of the metro network has been continued.

### 5.3 Purpose, Length and Duration of the Trips

The purposes of the trips on a typical weekday are shown in table 5.8, according to the survey of 1996. It can be seen that 64.8 % of the trips had work or study purposes.

**Table 5.8: Trip Purpose in Madrid Region in 1996**

Trip Purpose	(%)
Work	37.4
Study	27.4
Shopping	11.2
Others	24.0

Source: Cristóbal-Pinto (2002)

Considering only the motorised trips, the average distance travelled in Madrid was 8.1 km and the average duration of the trips was 42.4 minutes (EMTA, 2004b). Both figures correspond to the year 2002.

### 5.4 Public transport authority: Consorcio Regional de Transportes de Madrid

*Consorcio Regional de Transportes de Madrid* (CRTM) is the local authority responsible for the public transport system in Madrid Region. CRTM is an autonomous agency of the Regional Government (*Comunidad de Madrid*). It was created in 1985 as a unique public transport authority, gathering responsibilities of the Madrid Region and the adhered local governments (Cristóbal-Pinto, 2002). At the end of 2002 a total of 175 Municipalities, representing practically the entire population of Madrid Region, belonged to CRTM (CRTM, 2004a).

The main functions of CRTM are (Cristóbal-Pinto, 2002):

- the planning of transport services and definition of coordinated operating programmes for all public transport modes,
- the establishment of an integrated fare system for all the public transport system,
- the planning of public transport infrastructures and
- the creation of an overall image for the public transport system.

A more detailed analysis of CRTM is presented in chapter 7.

### 5.5 Car Travel

On the average, there were 186 park and ride places per suburban train station in Madrid Region in 2002. A comparison of the network lengths of the suburban train and the highways yields that there were 0.45 km of suburban train network for every kilometre of highway (EMTA, 2004b).

On the other hand, there were more than 14,500 taxis in Madrid Region in 2002 (EMTA, 2004b).

## 5.6 Metro and Suburban Rail

The first **metro** line in Madrid opened in 1919 with a length of 3.5 km. In 1926 the network was already 14.6 km long. An important extension of the metro network occurred between 1979 and 1983, when it grew by circa 50 % reaching a total length of 100 km. Another ambitious expansion plan was carried out later between 1995 and 1999, adding another 57 km to the network, reaching 171 km at the end of that period (Metro de Madrid, 2004a). Between 1999 and 2003 a new extension plan was executed, adding another 56 km to the metro network (Cristóbal-Pinto, 2002).

In 2005 the metro network in Madrid had 12 lines in operation with a total length of 227 km and 188 stations: 1 quadruple, 10 triple, 26 double and 151 single, i.e. without connecting lines. The rolling stock was comprised of 1,550 cars, with an average age of 11.7 years. The total supply of car-kilometres was 154.9 million during 2004. From them, 154.1 million corresponded to service car-kilometres. The network supply capacity was 221,909 in the peak hour by direction on the whole of the network (CRTM, 2004b, 2006a). In 2002 the average commercial speed in the metro system was 26.3 km/h (EMTA, 2004b p25).

618.4 million passengers were transported by metro in 2004 (IECM, 2006b). The demand of the metro system has strongly increased in the last years (table 5.9).

**Table 5.9: Evolution of the Demand of the Metro System in Madrid**

Year	Passengers/year (million)
1998	437.0
2000	523.6
2002	563.8
2004	618.4

Sources: IECM (2004e, 2006b)

The average occupancy of the metro vehicles was 14 % in 2002, when a total of 3,156 million passenger-kilometres were performed by metro and an offer of 22,006 million place-kilometres was provided (EMTA, 2004a).

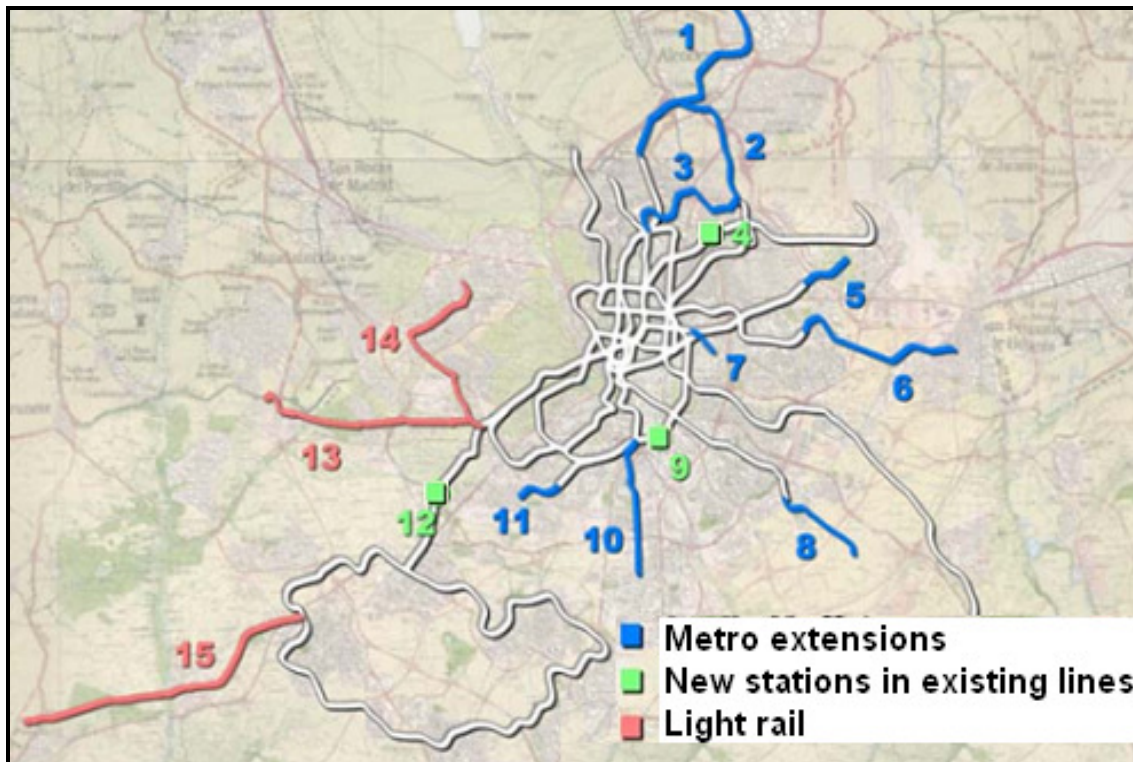
The main metro operator is Metro de Madrid, who is jointly owned by the municipality (75 %) and the region (25 %) placing all inherit rights due to shares ownership to CRTM (EMTA, 2004a p66). Metro de Madrid is responsible for 208 km of the network, all of which are inside Madrid City. The other 19 km are outside the municipality of Madrid and are exploited by the concession *Transportes Ferroviarios de Madrid*, which is partially owned by Metro de Madrid. Nevertheless, these 19 km are also directly managed by Metro de Madrid (CRTM, 2004b).

A new plan to expand the metro network has been designed, including 42 km of underground extensions distributed among 9 of the existing lines and 3 new light rail lines running on the



surface with a total length of 31 km (Comunidad de Madrid, 2005). The plan (figure 5.9) should be fully implemented by 2007.

**Figure 5.9: Metro and Light Rail Plan 2003-2007 in Madrid**



Source: Comunidad de Madrid (2005)

In addition to the metro, there were 12 lines of **suburban rail** (*Cercanías Renfe*) in Madrid Region in 2004 with a total length of 339 km (CRTM, 2006b) and 95 stations. On a working day 881,000 passenger trips were made in a programmed service of 1,385 daily trains in 2003. The rolling stock was formed by 257 trains (Cercanías Renfe, 2003 p7). 868 vehicles were in operation in 2002, running 102 million veh-km in a year at an average commercial speed of 53.5 km/h (EMTA, 2004b p15). The demand of the suburban rail has also been increasing in the last years (table 5.10).

**Table 5.10: Evolution of the Demand of the Suburban Rail System in Madrid**

Year	Passengers/year (million)
1998	143.5
2000	161.2
2002	193.7
2004	195.9

Sources: IECM (2004e, 2006b)

The suburban rail services are run by Renfe, the Spanish National Railways Company, which depends on the National Government of Spain (EMTA, 2004a p66).

## 5.7 Bus System

Bus services in Madrid Region can be divided into two types: the urban buses operated by *Empresa Municipal de Transportes de Madrid* (EMT) in Madrid City and the suburban buses operated by private companies in the entire region, especially outside Madrid City.

The first buses in Madrid ran in 1924. EMT was formed in 1947 and in 1950 it had a fleet of 581 vehicles. The fleet grew to 1,332 buses in 1970, reaching 1,824 in 1990 (EMT, 2005a).

In 2005, EMT had 1,958 **urban buses** operating 194 lines with an average fleet age of 5 years (CRTM, 2006c). In 2002 the network was 1,547 km long, with 3,972 stops (EMTA, 2004a). The number of veh-km increased in the last decade while the average speed ranged between 14 and 15 km/h (table 5.11).

**Table 5.11: Evolution of the Supply of the Urban Buses in Madrid**

Year	Veh-km/year (million)	Commercial speed (km/h)
1992	77	14.4
1995	90	14.7
1999	94	14.6
2002	96	14.0
2004	97	14.0

Sources: CRTM (2004c, 2006c)

1,715 standard buses, 81 articulated buses and 162 special vehicles composed the fleet (EMT, 2005a). This included 4 hydrogen powered buses, which were put experimentally in operation in 2004. Urban buses offered 7,739 place-kilometres in 2003 and performed 1,648 million passenger-kilometres (EMTA, 2005b p74). This yields an average occupancy of 21 % of the capacity.

Table 5.12 presents the evolution of the demand of the urban buses in the last decades. The highest patronage level was achieved in 1998. Afterwards, the demand decreased by 13 % between 1998 and 2004.

**Table 5.12: Evolution of the Demand of the Urban Bus System in Madrid**

Year	Passengers/year (million)
1970	357
1980	467
1990	440
1998	548
2000	531
2002	478
2004	475

Sources: IECM (2004e), EMT (2005a)

A physically separated bus and high occupancy vehicles (HOV) facility was implemented in 1995 in a 16.1 km long corridor between a suburban village (*Las Rozas*) and an interchange station (*Moncloa*) near the core of the city (figure 5.10). Although the corridor provides 3 to 4 general-purpose lanes, during the morning peak period 60 % of the passengers of the

corridor accessed Madrid through the BUS/HOV facility. The average car occupancy in the corridor increased from 1.36 passengers per car in 1991 to 1.67 in 1996. On the other hand, bus users increased by 111 % between 1991 and 1997 in the corridor (Cristóbal-Pinto, 2002).

**Figure 5.10: Bus/HOV Facility in Madrid**



Source: Cristóbal-Pinto (2002)

A plan to segregate the bus lanes in Madrid City began to be implemented in 2004, with the installation of physical separators along 22 km of bus lanes (EMT, 2005b). These represent only a small part of the 112 km of bus lanes that existed in Madrid in 2002 (EMTA, 2004b p29).

The **suburban bus** system in Madrid Region consisted of 389 lines in 2004, operated by 33 private companies under 44 franchises, with a fleet of 1,749 buses with an average age of 5 years (CRTM, 2006d). In 2003 the complete network was 3,396 km long, with 6,604 stops (EMTA, 2004a).

The demand of the suburban buses increased by 17 % between 1998 and 2004 (table 5.13). Suburban buses offered 10,156 place-kilometres in 2003 and performed 4,387 million passenger-kilometres (EMTA, 2005b p74), yielding an average occupancy factor of 43 %.

**Table 5.13: Evolution of the Demand of the Suburban Bus System in Madrid**

Year	Passengers/year (million)
1998	236.6
2000	270.1
2002	277.8
2004	276.2

Sources: IECM (2004e, 2006b)

An analysis about the public transport fare system and the financial aspects of public transport in Madrid is given in Chapter 8. Based on the data collected and presented in this and the previous chapters for London, Berlin, Madrid and Santiago de Chile, a comparison of these four cities is presented in the following chapter.

## 6. Comparison of the Metropolitan Areas and their Public Transport

### 6.1 Socio-economic Comparison

As seen in table 6.1, the largest metropolitan area from the four cases compared is Greater London, both in terms of population and area. Santiago has the highest density, followed by Madrid City, Greater London and Berlin.

**Table 6.1: Population, Area and Density of the Metropolitan Areas in 2005**

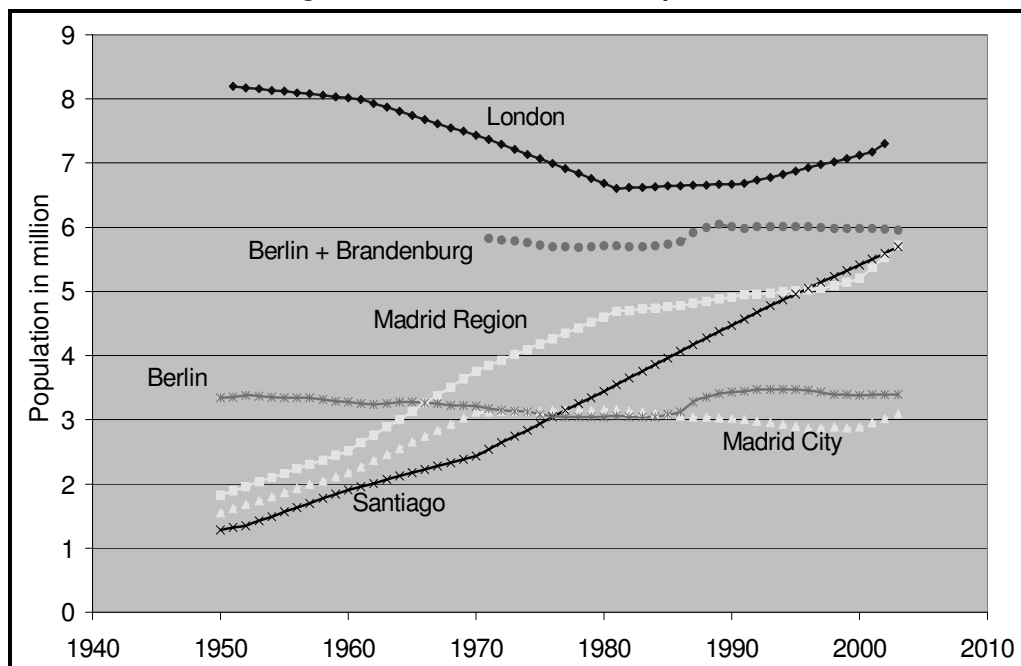
Metropolitan area	Population (million)	% of national population	Area (km <sup>2</sup> )	Density (people/km <sup>2</sup> )
Gran Santiago	5.9	37	860	6,900
Santiago Region	6.5	40	15,103	430
Greater London	7.5	12	1,579	4,750 <sup>(a)</sup>
Berlin	3.4	4	892	3,800
Berlin-Brandenburg	6.0	7	30,367	196
Madrid City	3.2	7	606	5,280
Madrid Region	6.0	14	8,028	750

<sup>(a)</sup> The central area has a density of 5,900 people/km<sup>2</sup>

Source: own elaboration based on data of the previous chapters

The population in Gran Santiago and Madrid Region have been growing steadily in the last 50 years, but the population of Madrid City has remained stable since 1970 (figure 6.1). The population of Berlin has shown little changes since 1950, while the added population of Berlin and Brandenburg remained more or less stable since 1970. The population of Greater London declined until 1980 and grew afterwards.

**Figure 6.1: Evolution of the Population**



Source: own elaboration

When comparing the per capita gross domestic product (GDP) Santiago has a much lower GDP than the European metropolitan areas (table 6.2). For the latter the per capita annual GDP is approximately 5 times higher than for Santiago. It is interesting to note that the GDP per capita is very close in the European metropolitan areas.

Regarding the relative importance of each metropolitan area in their countries, London and Madrid have about 10 % of the national population (table 6.1), but 18 % of the national GDP. Santiago has 38 % of the national population and 47 % of the national GDP. The three metropolitan areas are important in terms of population in the country, but even more so in terms of GDP. In the case of Santiago the “weight” of the city in the country is even greater than in London and Madrid. Berlin in contrast has only 4 % of the population of Germany.

**Table 6.2: Per Capita Annual GDP**

Metropolitan area	Year	Per capita annual GDP (€)	National GDP produced in the capital (%)
Santiago	2000	4,700 <sup>(a)</sup>	47
Greater London	2002	26,500	18
Berlin	2003	22,700	N/A
Madrid	2002	23,900	18

<sup>(a)</sup> Per capita annual GDP of Chile

Source: own elaboration based on data of the previous chapters

Besides the difference in the average income, there are huge differences in the income distribution in the researched countries. Table 6.3 shows an inequity index reported by the United Nations Development Programme (UNDP, 2005b), which compares the income of the richest 10 % of the population with the poorest 10 %. This index has a very high value of 40.6 in Chile, whereas it ranges between 13.8 and 6.9 in the three European countries analysed.

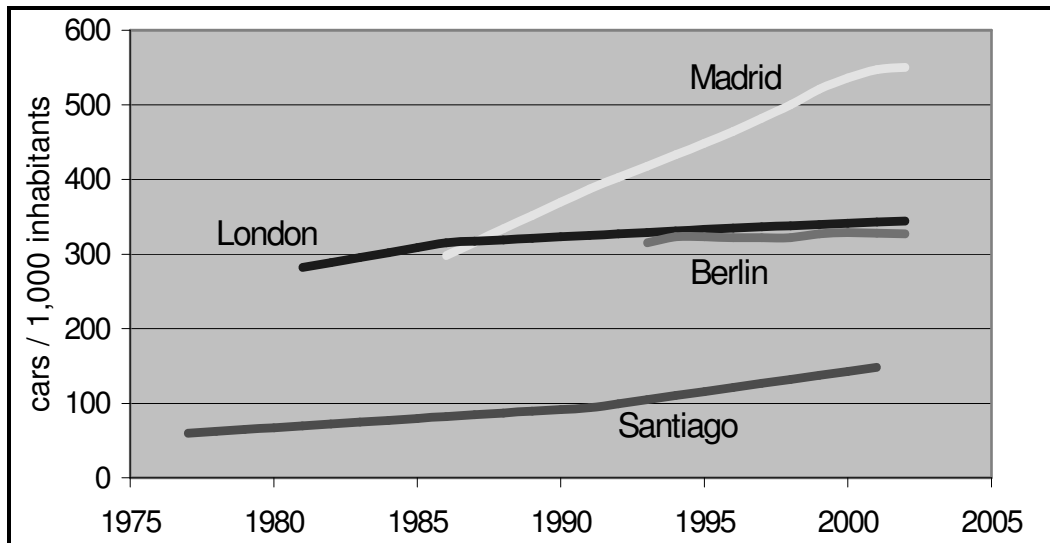
**Table 6.3: Inequity Index in the Four Countries**

Country	Inequity index <sup>(a)</sup>
Chile	40.6
United Kingdom	13.8
Germany	6.9
Spain	9.0

<sup>(a)</sup> Average income of the richest 10 % divided by the average income of the poorest 10 %

Source: UNDP (2005b)

At the beginning of the 2000s, Madrid Region had the highest motorisation rate (550 cars per 1,000 inhabitants) of the four metropolitan areas, while Santiago presented the lowest one (148 cars per 1,000 inhabitants). Berlin and London had very close figures around the 330 or 340 cars per 1,000 inhabitants (figure 6.2 and table 6.4). Although yearly data about the motorisation rate in Madrid City was not available, in 2002 the motorisation rates in Madrid City and Madrid Region were very similar: 546 and 550 cars per 1,000 inhabitants, respectively (table 6.4).

**Figure 6.2: Evolution of the Motorisation Rates**

Source: own elaboration

In the last decades, the motorisation rates in Santiago and Madrid have been growing much faster than in London and Berlin. The average yearly motorisation rate increased in the former by 3.8 % and 3.9 % respectively, while the latter grew at only 1.0 % and 0.4 % respectively (table 6.4).

**Table 6.4: Average Yearly Motorisation Rate Increase**

Metropolitan area	Initial year	Motorisation rate (cars / 1,000 inhab)	Final year	Motorisation rate (cars / 1,000 inhab)	Average yearly motorisation rate increase (%)
Santiago	1977	60	2001	148	3.8
Greater London	1981	282	2002	344	1.0
Berlin	1993	315	2002	327	0.4
Madrid Region	1986	298	2002	550	3.9
Madrid City			2002	546	

Source: own elaboration based on data of the previous chapters

It is possible that Santiago's motorisation rate continues rising at a high speed, as was the case in Madrid. The cases of London and Berlin show that it is also possible to reduce the speed of the motorisation rate. With little more than 300 cars per 1,000 inhabitants, the motorisation rates in London and Berlin grow by 1 % per year, far more slowly than the 3.9 % of Madrid and the 3.8 % of Santiago.

## 6.2 Modal Split Analysis

In order to compare the modal splits in the four metropolitan areas, only motorised trips will be considered here. In fact, different methodologies when counting the non-motorised trips would imply biased comparisons if those trips were considered. The data for each metropolitan area correspond to the newest information available about passenger trips, and it ranges between 1996 for Madrid and 2003 for London. It can be seen that Santiago had

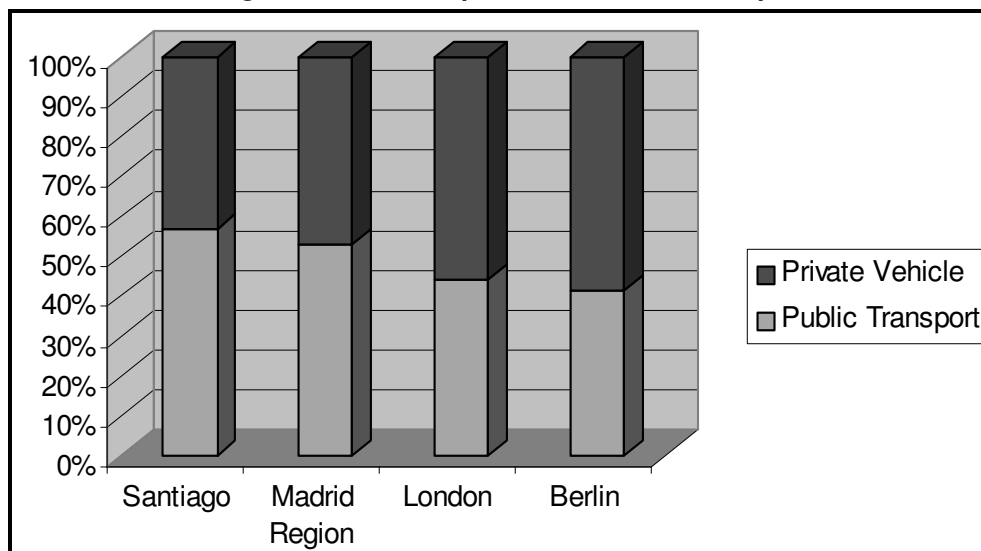
the highest public transport modal split, while Berlin showed the highest use of private vehicle (table 6.5 and figure 6.3).

**Table 6.5: Modal Split of the Motorised Trips**

Metropolitan area	Public transport (%)	Private vehicle (%)	Year
Santiago	57	43	2001
Greater London	44	56	2003
Berlin	42	58	1998
Madrid Region	53	47	1996

Source: own elaboration based on data of the previous chapters

**Figure 6.3: Modal Split of the Motorised Trips**



Source: own elaboration

Regarding the distribution of the public transport trips, table 6.6 and figure 6.4 present the daily modal split among public transport modes. The bus is the most used public transport mode followed by the metro and the rail in almost all the metropolitan areas. The only exception is Berlin, where the underground use is slightly higher than the bus use. The modal split of tram is important only in Berlin. London has a very small tram network, while Santiago and Madrid did not have trams at all in 2006.

**Table 6.6: Public Transport Modal Split<sup>(a)</sup>**

Metropolitan area	Bus (%)	Metro (%)	Rail (%)	Tram (%)	Year
Santiago	87 <sup>(b)</sup>	13	<1	-	2001
Greater London	48	31 <sup>(c)</sup>	21	<1	
Berlin	30	33	25	12	2002
Madrid Region	50	37	13	-	2002

<sup>(a)</sup> Modal split in terms of passenger trips or stages. <sup>(b)</sup> Includes bus (79%) and shared-taxi (8%).

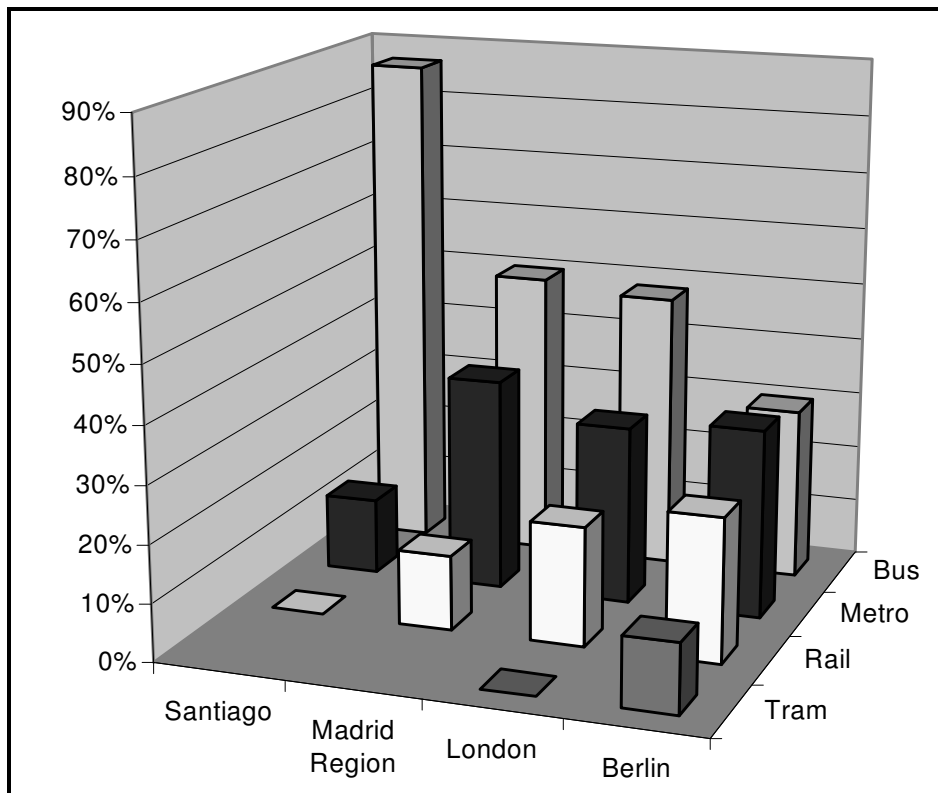
<sup>(c)</sup> Includes Underground (30%) and Docklands Light Railway (1%).

Source: own elaboration based on data of the previous chapters

Berlin presents the most diversified public transport use, with no single public transport mode having more than one third of the trips. On the other hand, Santiago presents the highest bus modal split, and the lowest use of other public transport modes. This is explained by the comparatively smaller metro and urban rail networks, as will be shown later. In London and

Madrid, approximately 50% of the public transport trips are made by bus. In both metropolitan areas the use of metro is higher than the use of suburban rail, but this effect is more pronounced in Madrid than in London.

**Figure 6.4: Modal Split of the Public Transport Trips**



Source: own elaboration

The total number of public transport trips per year is presented in table 6.7, along with the yearly public transport trips per inhabitant and the GDP per capita. As can be seen in figure 6.5, London has the highest rate of public transport trips per inhabitant, followed by Berlin, Santiago and Madrid. The most similar figures correspond to Santiago and Madrid.

**Table 6.7: Yearly Public Transport Trips per Inhabitant**

Metropolitan area	Year	Yearly public transport trips (million)	Population (million)	Yearly public transport trips per inhabitant	Per capita annual GDP (€)
Santiago	2001	1,600 <sup>(a)</sup>	5.5	291	4,700 <sup>(b)</sup>
Greater London	2002	3,189	7.3	437	26,500
Berlin	2003	1,205	3.4	354	22,700
Madrid Region	2002	1,514	5.5	275	23,900

<sup>(a)</sup> Some 200 million shared-taxi trips are included. <sup>(b)</sup> Per capita annual GDP of Chile in 2000.

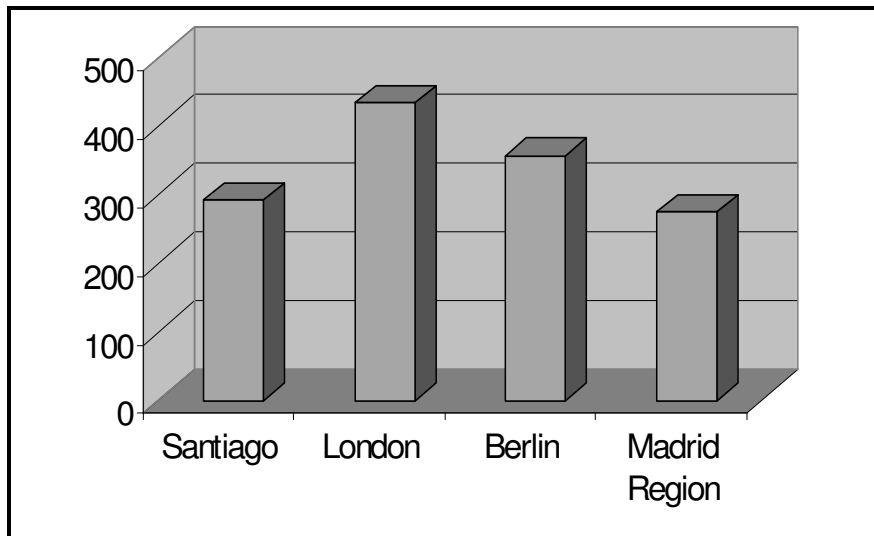
Source: own elaboration based on data of the previous chapters

Although it is frequently thought in Santiago that its public transport demand is much higher than the public transport demand of European metropolitan areas, table 6.7 and figure 6.5 show that this is not true. Santiago has a comparatively low rate of public transport trips per inhabitant. The explanation for this misunderstanding is that the proportion of public transport trips made by bus is higher in Santiago than in the European capital cities. This implies that most of the public transport trips are made “on the street” in the more visible public transport



mode: the bus. On the contrary, the European metropolitan areas “hide” a bigger proportion of their public transport trips in massive modes like underground or trains.

**Figure 6.5: Yearly Public Transport Trips per Inhabitant**



Source: own elaboration

### 6.3 Comparison of the Underground, Tram and Suburban Rail Supplies

The metro supply comparison presented in table 6.8 shows that Santiago has a much smaller metro system, which was developed during the last decades. This contrasts with the much earlier metro systems of the European metropolitan areas, especially the London Underground.

**Table 6.8: Metro Supply Comparison <sup>(a)</sup>**

Metropolitan area	Number of lines	Network length (km)	Number of vehicles	Average commercial speed (km/h)	First line opened in year
Santiago <sup>(b)</sup>	4	67	636	32.0	1975
Greater London <sup>(c)</sup>	12	408	4,070	33.0	1863
Berlin	9	144	1,368	31.1	1902
Madrid Region	12	227	1,550	26.3	1919

<sup>(a)</sup> Data corresponds to year 2005. <sup>(b)</sup> By the end of 2006 Santiago had 4 metro lines with a total length of 83 km. <sup>(c)</sup> Includes Underground and Docklands Light Railway.

Source: own elaboration based on data of the previous chapters

Table 6.9 shows the tram systems of the analysed metropolitan areas. It is interesting to note that the big tram network of Berlin that runs mainly in the east part of the city complements the metro network of the western areas.

**Table 6.9: Tram Supply Comparison <sup>(a)</sup>**

Metropolitan area	Number of lines	Network length (km)	Number of vehicles	Average commercial speed (km/h)	First electric line opened in year
Santiago	-				
Greater London	3	28	24	N/A	1901 <sup>(b)</sup>
Berlin	22	188	600	19.3	1895
Madrid Region	-				

<sup>(a)</sup> Data corresponds to year 2005. <sup>(b)</sup> No trams ran in London between 1952 and 2000.

Source: own elaboration based on data of the previous chapters

The suburban rail systems are compared in table 6.10. Again, Santiago has a much smaller system than the European metropolitan areas. The higher commercial speed of the rail system in Santiago (called *Metrotrén*) is a result of its mainly interurban character (it has only 5 stations inside Santiago and a total length of 142 km).

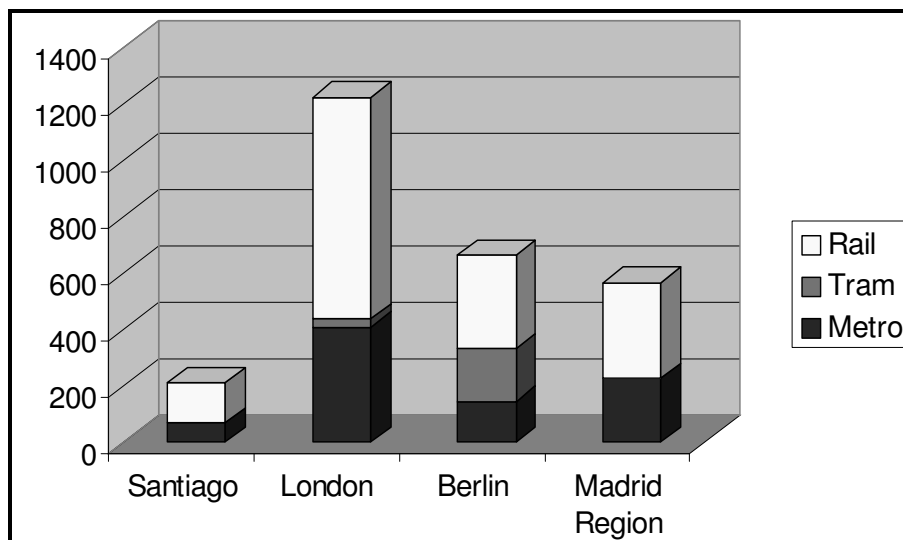
**Table 6.10: Suburban Rail Supply Comparison <sup>(a)</sup>**

Metropolitan area	Number of lines	Network length (km)	Number of vehicles	Average commercial speed (km/h)
Santiago <sup>(b)</sup>	1	142	39	81
Greater London	10 <sup>(c)</sup>	788	N/A	56
Berlin <sup>(d)</sup>	16	331	733	N/A
Madrid Region	12	339	868	54

<sup>(a)</sup> Data corresponds to years 2003 to 2005. <sup>(b)</sup> Metrotrén is mainly an interurban service, with 5 stations inside Santiago. <sup>(c)</sup> In the case of London, the figure corresponds to the number of companies instead of lines. <sup>(d)</sup> S-Bahn

Source: own elaboration based on data of the previous chapters

Figure 6.6 shows the network length of the metro, tram and suburban rail in the four metropolitan areas.

**Figure 6.6: Network Length of the Rail Modes (km)**

Note: Rail supply in Santiago (*Metrotrén*) is mainly interurban.

Source: own elaboration

In table 6.11 and figure 6.7 the metro, tram and suburban rail supplies per inhabitant are shown, in terms of kilometres of network per million inhabitants. London and Berlin present figures of 163 and 194 km/million-inhab respectively, while Madrid has 95 km/million-inhab. Santiago has a much lower amount, with 14 km/million-inhab (without taking into account the *Metrotrén*, as it is mainly an interurban service). Even with the doubling of the metro network in Santiago between 2003 and 2006, the rail supply per inhabitant remains below the supplies of the three European metropolitan areas.

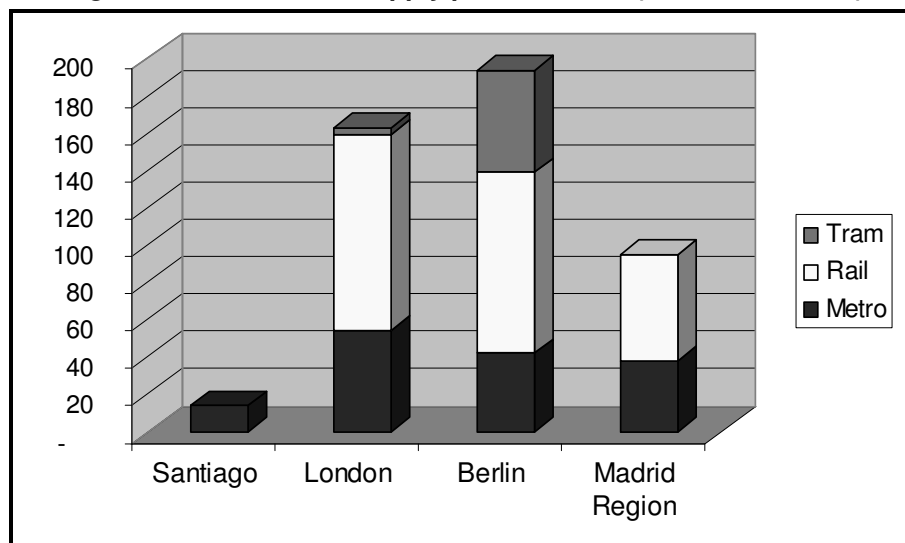
**Table 6.11: Metro, Tram and Suburban Rail Supplies per Inhabitant <sup>(a)</sup>**

Metropolitan area	Population (million)	Metro network (km/million-inhab)	Tram network (km/million-inhab)	Rail network (km/million-inhab)	TOTAL network (km/million-inhab)
Santiago	5.9	14	-	24 <sup>(b)</sup>	14 <sup>(c)</sup>
Greater London	7.5	54	4	105	163
Berlin	3.4	42	55	97	194
Madrid Region	6.0	38	-	57	95

<sup>(a)</sup> Data corresponds to year 2006. <sup>(b)</sup> Metrotrén is mainly an interurban service. <sup>(c)</sup> Metrotrén not included

Source: own elaboration based on data of the previous chapters

**Figure 6.7: Rail Modes Supply per Inhabitant (km/million-inhab)**



Note: Rail not included in Santiago (mainly an interurban service)

Source: own elaboration

## 6.4 Bus Supply Comparison

In table 6.12 the main characteristics of the bus supply in 2005 are compared. In the case of Santiago, the characteristics of the new bus system that should be implemented by the beginning of 2007 are also included. In the case of Madrid, the bus system is divided into the urban buses that operate in Madrid City and the suburban buses that operate in the rest of the Region. The highest commercial speed is found in Berlin with 20 km/h, while the lowest is in Madrid City (14 km/h). Bus operators in Berlin and Madrid City are publicly owned

monopolies, while Santiago, London and Madrid Region have many private bus operators. The new bus system in Santiago will drastically reduce the number of operators from 4,000 to 10.

**Table 6.12: Bus Supply Comparison <sup>(a)</sup>**

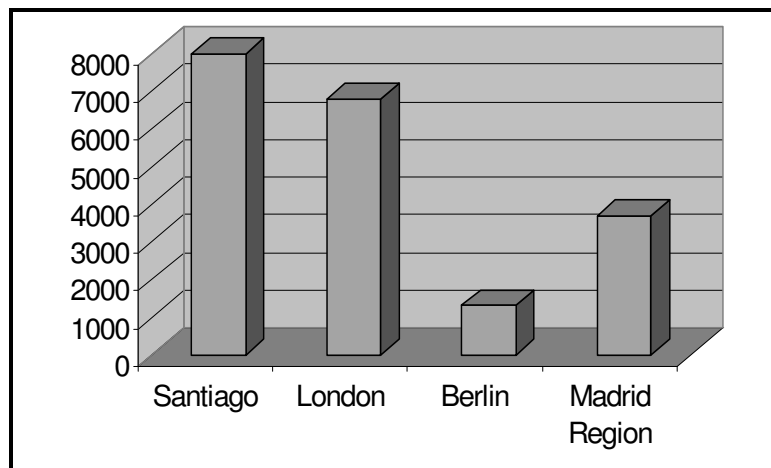
Metropolitan area	Number of lines	Number of operators	Network length (km)	Number of vehicles	Average commercial speed (km/h)
Santiago	380	4,000	N/A	8,000	N/A
<i>Santiago <sup>(b)</sup></i>	<i>160</i>	<i>10</i>	N/A	<i>5,000</i>	N/A
Greater London	700	30	3,730	6,800	17
Berlin	151	1	1,662	1,328	20
Madrid City <sup>(c)</sup>	194	1	1,547	1,958	14
Madrid Region <sup>(d)</sup>	389	33	3,396	1,749	N/A

<sup>(a)</sup> Data corresponds to year 2005. <sup>(b)</sup> Estimated data for the new bus system of Santiago that should begin operation in 2007. <sup>(c)</sup> Urban buses. <sup>(d)</sup> Only suburban buses are considered

Source: own elaboration based on data of the previous chapters

Figure 6.8 shows the number of buses in each metropolitan area. Santiago and London have the highest amount of buses, and Berlin the lowest.

**Figure 6.8: Number of Buses in Each Metropolitan Area**



Data corresponds to year 2005

Source: own elaboration

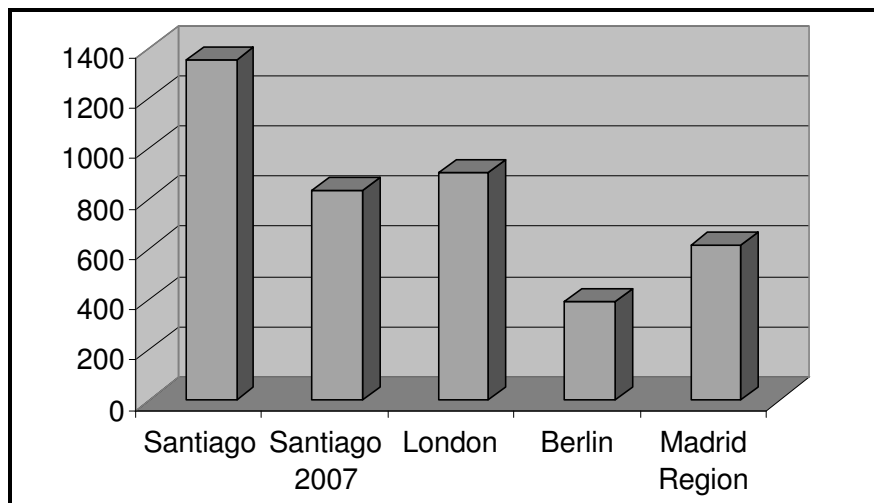
Table 6.13 and figure 6.9 show the buses per million inhabitants in the four metropolitan areas. Currently, Santiago has a clearly higher amount in comparison with London, Berlin and Madrid. However the new bus system to be implemented by the beginning of 2007 will imply a reduction in the total bus fleet yielding a reduction to 833 buses per million inhabitants. The new figure will be comparable to the amounts found in the European capital cities. It will be higher than Berlin (391) and Madrid (618), but lower than London (907).

**Table 6.13: Bus Supply per Inhabitant**

Metropolitan area	Population (million)	Buses per million inhabitants
Santiago	5.9	1,356
<i>Santiago<sup>(b)</sup></i>	<i>6.0</i>	<i>833</i>
Greater London	7.5	907
Berlin	3.4	391
Madrid Region	6.0	618

<sup>(a)</sup> Data corresponds to year 2005. <sup>(b)</sup> Estimated data for the new bus system of Santiago that should begin operation in 2007

Source: own elaboration based on data of the previous chapters

**Figure 6.9: Buses per Million Inhabitants**

Source: own elaboration

## 6.5 A Final Comment on the Comparison of the Metropolitan Areas

In chapters 2 to 5 socio-economic and transport data for Santiago de Chile, London, Berlin and Madrid was presented. In the present chapter this information was summarised in a comparative analysis of the four metropolitan areas.

During all the work that was made so far, both for the data collection and the analysis of the information, the main aim of this research was kept in mind, namely the identification of aspects in which the public transport system of Santiago could be improved, basing in positive experiences provided by the three European metropolitan areas investigated.

Four main areas were identified, in which further analysis and recommendations could be made:

- **Institutional organisation of public transport:** public transport authority, incentives for the operators.
- **Operational issues:** priority measures for public transport, frequencies and schedules design and optimisation, lines density analysis, users' information.

- **Financial and fare aspects:** fare structure, fare level comparison, subsidies, travelcards.
- **Physical design:** bus-stops design, interchange-stations design.

Taking into account both the time constraints of the research and the length restrictions of the dissertation, it was decided that **two topics** should be selected for further analysis.

The first selected topic was the analysis of the **public transport authorities**, i.e. the institutional organisation of the public transport systems. The existence of public transport authorities in the European study cases strongly contrasts with the absence of such an authority in Santiago: in fact, there is no authority comprehensively responsible for the public transport in Santiago. On the contrary, there are several authorities responsible for different aspects of the public transport system. This causes a complicated and often missing coordination. The author thinks that this is a highly relevant issue for Santiago, which should be solved urgently. The absence of a sound public transport authority makes any optimisation of the public transport system difficult and slow, and decreases the probability of success of any measure designed to improve it. The development of a proposition for the creation of a public transport authority in Santiago is the aim of the analysis presented in chapter 7.

A rather limited knowledge and experience of the author in physical-design topics quickly suggested that this issue should be discarded. Therefore, operational issues and financial aspects were the candidates to be the last topic investigated in this research. Both had been previously analysed by the author from a theoretical microeconomic viewpoint (see Gschwender, 2000; Jara-Díaz and Gschwender 2003a, 2003b, 2005) and were therefore well-suited for a more practical orientated research now.

After considering the empirical and theoretical information available, the **financial and fare aspects** were selected for further analysis. Especially interesting was the finding of a generalised use of travelcards in European metropolitan areas (together with some evidence of patronage increases attributable to the travelcards), again contrasting with Santiago where this kind of period tickets are not used. A recommendation in this direction, together with analysis and recommendations regarding fare integration, fares reductions in specific periods or areas, the relation between fare and trip-distance, subsidies and average fare levels are presented in chapter 8.

## **7. Transport Authority: European Experiences and Recommendations for Santiago**

It has been detected that the institutional organisation of the public transport system is a key aspect in which important differences exist between the analysed metropolitan areas, especially between Santiago and the European capital cities. In this chapter these different forms of organisation are investigated, with the aim of drawing recommendations for Santiago. The author sees that there is scope for an important improvement of the institutions behind the public transport in Santiago, and the aim of this chapter is to show how it can be improved, based on the comparative experiences of London, Berlin and Madrid.

The authorities responsible for the transport system in Santiago have much less influence on the public transport system than in most European countries. Indeed, there is no authority comprehensively responsible for public transport in Santiago. On the contrary, there are several agencies responsible for different aspects of the public transport system. Thus, the responsibilities for the regulation, planning, metro construction and operation, road safety, traffic light coordination, road maintenance, etc. are distributed among different ministries, municipalities (34, with self-elected political authorities) and technical offices. This causes a complicated and often missing coordination.

A different reality is found in the three selected large European metropolitan areas (London, Berlin and Madrid) where there are public transport authorities, being responsible for the different issues of the public transport system. A more comprehensive view is needed to understand the different forms of organisation in the three study areas.

The institutional organisation of the transport system in Santiago is presented next, followed by an analysis of the public transport authorities in London, Berlin and Madrid. Then, the organisation of the public transport authorities in the four metropolitan areas is compared and discussed, and finally a recommendation for Santiago based in the European cases is described.

### **7.1 The Public Transport Institutional Organisation in Santiago**

Ken Gwilliam, transport economist of the World Bank specialised in the design of regulatory systems, has been researching the organisation of the urban transport systems in different large metropolitan areas in developing countries around the world (especially Latin-America and Asia). One of his conclusions is that:

“A critical failure of most developing country cities is the absence of adequate mechanisms for achieving spatial coordination. This is often associated with the traditional rights of independent municipalities, and often political conflict between central, state and municipal governments, all of which have some responsibility” [in the transport system] (Gwilliam, 1999 p13).

This diagnosis fits well into the problems that Santiago de Chile suffers. But let us analyse in detail Santiago's transport institutional organisation.

### 7.1.1 Municipalities and the regional government

Chile is administratively divided into 13 regions. The president and ministries have country-wide responsibilities and the ministries usually have a regional office for each one of the 13 regions.

The conurbation called *Gran Santiago* is formed by 34 municipalities, each one of which has a mayor directly elected by the inhabitants. The transportation responsibilities of the municipalities are mainly administrative: maintenance of the local road network (smallest streets), installation and maintenance of the street furniture at the bus stops and permissions for the installation of bus depots in specific places.

There is a regional government that is responsible for the whole Metropolitan Region. As can be seen in figure 7.1 the Metropolitan Region is larger than the urban area of Santiago. Even so it has almost no responsibility in transport issues. The head of the regional government is called “*intendente*” and is appointed by the president of the country. So, the *intendente* is a regional representative of the president, and not a direct representative of the inhabitants of the region.

Figure 7.1: Metropolitan Region of Santiago





### 7.1.2 Transport and telecommunications ministry

The body officially responsible for urban public transport policies is the transport and telecommunications ministry (*ministerio de transporte y telecomunicaciones*, MTT), especially through its regional secretaries. In Santiago and the other large conurbations of Chile (Gran Concepción and Gran Valparaíso) the national authorities of the ministry are usually directly concerned with the transport issues of the metropolitan areas.

The main tasks of the transport ministry are the formulation of policies for the transport sector, and its enforcement. In terms of urban public transport, a law approved at the beginning of the 1990s allows the transport ministry to regulate the public transport operation in areas where high levels of congestion, pollution or accidents are found and can be ascribed to the public transport system. This law was designed to introduce regulation into the fully deregulated bus system that existed in Santiago by the end of the 1980s.

According to the Chilean constitution, no public agency is allowed to commercially participate in any industry if the private sector already exploits that business. In the case of the urban public transport, this implies that only private operators are allowed. The only exceptions are rail-based modes (e.g. Metro), which are allowed by special laws to operate in public hands. So, the only participation that the state can have in the urban public transport system is the operation of electrical rail modes and the regulation and tendering of the bus system.

By the end of the 1980s, an agency called Traffic Control Operative Unit (*Unidad Operativa de Control de Tránsito*, UOCT) was created, taking over the control of all the traffic signals of Santiago. The UOCT is part of the transport ministry, although it only has responsibilities in Santiago.

It is interesting to note how national and local responsibilities are mixed inside the transport ministry. Also remarkable is that previously both the transport ministry and the municipalities were responsible for the management of the traffic lights, the latter being in charge of the traffic signs in minor streets. So the UOCT took over that responsibility from the municipalities.

### 7.1.3 Other ministries involved in the transport system

There are also other agencies with important transportation responsibilities outside the transport ministry. New road infrastructure is financed (and decided) by two other ministries: the public works ministry and the housing and urban planning ministry.

At a national level the public works ministry is responsible for the construction and maintenance of interurban roads. This also applies for the sections of those roads that are inside Santiago. After a successful expansion and improvement of the main interurban roads of the country through a public-private partnership (PPP) system of concessions, the public works ministry designed a network of urban highways for Santiago that was also constructed through a PPP system. Some new highways are being considered by the public works ministry in order to extend this network. Although an attempt to merge the transport and public works ministries was made in 2000 by appointing a single minister for both

secretaries, the structures of the ministries remained unaltered. Moreover, separate ministers were appointed again in 2006.

The housing and urban planning ministry (*ministerio de vivienda y urbanismo*, MINVU) is responsible for maintenance of the majority of the urban roads<sup>4</sup>. Included is also for instance the construction of busways or the redesign of bus stops. This has shown to be a problem in the practice. In fact, in the past MINVU has not been very interested in building facilities to improve the public transport system. Although the ministry sometimes includes the construction of public transport facilities in its budget, these are the first to be cancelled when the budget needs to be revised later. It should not be forgotten that the housing and urban planning ministry (and its minister) is mainly evaluated for its successes in diminishing the housing deficit.

Together with the municipalities, MINVU is also responsible for the land-use planning: the municipalities at the local level, and the housing and urban planning ministry at metropolitan and regional levels.

#### **7.1.4 Publicly owned operators**

There are two independent operators that are publicly owned: the Metro and the *Metrotrén* suburban train. They have no direct relation with the transport ministry. The most important is the metro, whose director is appointed by the president of Chile. Thus the company is not accountable to any local authority, but to the president of the country. Although the main task of the company is the operation of the metro system, it sometimes also develops plans for extensions of the network and construction of new lines which are decided by the president of Chile.

The other is the suburban train called *Metrotrén*. It is run by the state railways company (*empresa de ferrocarriles del estado*, EFE), also a publicly owned company. Again, the director of EFE is appointed by the president of Chile. Nevertheless, *Metrotrén* has only little importance in terms of the proportion of the urban trips that are made in it.

#### **7.1.5 Coordinating commissions**

From time to time, the absence of a sound authority responsible for transport affairs in Santiago becomes evident, because a problem develops where nobody feels responsible. So far, the typical response has been the creation of an inter-ministerial commission to solve the particular difficulty.

By the beginning of the 1980s congestion was becoming a problem in Santiago. The absence of an authority responsible for that problem yielded the creation in 1981 of a commission of ministers that included, among others, the minister for transport and telecommunications, the minister for public works and the minister for housing and urban planning. The initial aim of the commission was the creation of an infrastructure plan to solve

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<sup>4</sup> With the exception of those roads that are a responsibility of the municipalities or the public works ministry.

the congestion problems of the capital. The commission created an executive secretary called SECTRA, which developed modelling tools, projects and plans. Over the years, SECTRA became a national scope office, collecting data and developing models, projects and transportation plans for all large and medium size cities in the country, as well as for the interurban transport system. SECTRA even survived the ministers commission that created it, which last met in the middle of the 1990s. But the original aim of coordinating public agencies became very difficult after the ministers commission disappeared. In fact, SECTRA has no responsibility in the actual implementation of what it plans, i.e. it does not manage any budget for the construction of transport projects. So it is not unusual that projects recommended by SECTRA never get built, while projects planned by other agencies do get constructed. Nevertheless, SECTRA is still the main transportation planning office in Santiago and in the country. The two most relevant projects for the management and improvement of Santiago's transport system in the last decades were planned there: the UOCT (coordination of traffic lights), and the new integrated bus and metro system called *Transantiago*.

In 1993, another commission of ministers was created with the aim of analysing the security problems of the transportation system (*comisión nacional de seguridad de tránsito*, CONASET). The commission is formed by 9 ministers (including the minister for transport and telecommunications, the minister for public works and the minister for housing and urban planning) and the police director, and it also has an executive secretary. The main task of its executive secretary is the proposition of projects, plans and policies to reduce traffic accidents.

In 1994, a commission indirectly related with transport policies was created. It is called *comisión nacional del medio ambiente* (CONAMA) and its objective is the coordination of the different agencies in environmental issues. It is formed by 14 ministers, including transport and telecommunications, public works and housing and urban planning.

In 1996, a ministers committee of land-use and urban development (*comité de ministros de desarrollo urbano y ordenamiento territorial*) was created. It is formed by 5 ministries, including the minister for transport and telecommunications, the minister for public works and the minister for housing and urban planning. The main objective of this committee is the analysis of land-use and urban development policies and plans.

But the most relevant commission for the public transport system of Santiago was created in 2003 in order to implement *Transantiago*, the new integrated bus and metro system. It is formed by the ministry of transport and telecommunications, the ministry of public works, the ministry of housing and urban development, the ministry of finance, the regional government, SECTRA and CONAMA. The executive secretary is called after the name of the plan (*Transantiago*) and has the responsibility of coordinating the plan and tendering its different contracts to the private sector.

### 7.1.6 Role of the president of Chile

The most important public agencies responsible for the implementation of transport policies, plans and projects are three ministries (transport and telecommunications (including the UOCT), public works and housing and urban development), one state owned operator (metro) and three coordinating agencies (Transantiago, SECTRA and CONASET). None of these bodies is accountable to any local government (municipalities or regional government). On the contrary, all of them are only accountable to the president of Chile. Therefore, the president of the country is primarily responsible for the transport policy of Santiago.

In the last years the president had to solve effectively key coordination problems between different agencies. For instance, there was a problem between the Metro and the transport minister regarding the inclusion of the Metro to an integrated fare system that will be implemented as part of the new bus (and metro) system *Transantiago*. Metro did not concur with the financial guarantees of the system and, as the conflict finally threatened the successful implementation of the project, the president of Chile had to intervene. After a week of daily meetings, he ordered Metro to enter the new system (Las Últimas Noticias, 2005; El Mostrador, 2005).

Given that the president of the country obviously has mostly national responsibilities, it does not seem to be the ideal authority to rule the transport issues of a particular metropolitan area. In addition, it has to be taken into account that Santiago, although being the largest metropolitan area of the country, is not the only conurbation where similar problems of coordination of the transportation agencies can be found. Finally, the experience has shown that this institutional organisation is not adequate to solve the transport problems.

Two examples help to illustrate the effects of the bad institutional organisation. Santiago is probably the only metropolitan area in the world where efforts have been duplicated by the development of transportation models. Both SECTRA and the public works ministry have independently built four-steps transportation models (generation, distribution, modal split and assignment) for Santiago (ESTRAUS and STGO). And they have also separately developed land-use/transportation models for the metropolitan area (MUSSA and MEPLAN). On the other hand, a new metro line to the western municipality of Maipú was decided only months after a new busway had been constructed linking the same municipality with the centre of the city. To avoid building the metro line just under the recent inaugurated road, the metro line was not designed through the shortest path, but using other streets over a longer route.

A comprehensive list of problems caused by the bad institutional organisation in the transport system (and especially the public transport system) of Santiago would be long. It can be concluded that a new institutional organisation is needed for the transport affairs in Santiago. Better experiences can be found in other metropolitan areas of the world, as will be seen in the next section.

## 7.2 Public Transport Authorities in Selected European Metropolitan Areas

The public transport institutional organisation in three European metropolitan areas was examined here (London, Berlin and Madrid), seeking recommendations for the improvement of the situation in Santiago.

### 7.2.1 Greater London

The public transport system of Greater London is a responsibility of a local transport authority called Transport for London (TfL), created in 2000. TfL is accountable for both the planning and delivery of transport facilities (TfL 2004b). It is responsible for London's buses, the underground, the Docklands Light Railway and the management of Croydon Tramlink and London River Services (TfL, 2005a), i.e. almost all public transport services of the capital city. The main exceptions are the 10 private rail companies that operate the national rail lines in Greater London. Although TfL is not directly responsible for national rail services, a partnership has been established with the Strategic Rail Authority to develop national rail's contribution to an integrated public transport system in Greater London (EMTA 2004a p62). In addition, the responsibility for the management of the rail services collectively known as the North London Railway will be transferred to TfL by 2007. TfL will manage the concession which will be run under the name "Overground" by a train operator to standards specified by TfL. London Overground services will also run on the East London Railway when it opens in 2010 (TfL, 2006e, 2006f). TfL is also responsible for a 580km network of main roads (called Transport for London Road Network) and all of London's 4,600 traffic lights. In addition, TfL manages the central London Congestion Charging scheme and regulates the city's taxis and private hire trade. Therefore, TfL is not only responsible for the public transport system, but also has responsibilities in the private transport sector. In addition, TfL promotes walking and cycling initiatives and coordinates schemes for transport users with impaired mobility. So it can be said that Transport for London is a local authority responsible for the majority of **Greater London's transport system**. With 17,000 employees, it operates through several subsidiary companies.

TfL manages the bus services, planning routes, specifying service levels, monitoring service quality and being responsible for bus stops (EMTA, 2004a p63). The bus services are run by private operators working under contract to TfL, through a route tendering system. Contracts are awarded for five years with an option for a two-year extension. Around twenty per cent of the market comes up for re-tender in a year. Quality incentive contracts for London's bus services were introduced in October 2001. Operators are given incentives and deductions relating to delivering quality and reliability according to set targets. The performance of each route is monitored by London Buses and action can be taken at any time if the route is not up to standard (TfL 2004k).

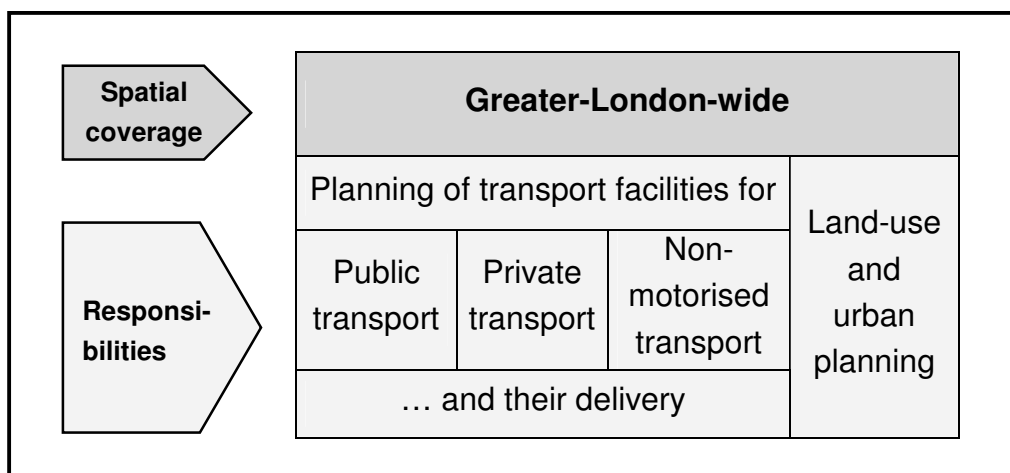
The responsibility for the Underground was transferred to TfL in 2003, and London Underground was merged with TfL (EMTA, 2004a p63). London Underground had more than 12,000 staff in 2005 (TfL, 2005b), i.e. 70 % of the total employees of TfL. London Underground is responsible for running the London Underground rail network including stations, train operations and signalling. Two private sector partners, Metronet and Tube

Lines, are responsible for maintaining and upgrading London Underground's infrastructure. Responsibility for safety remains with London Underground (TfL, 2005c). Docklands Light Railway, a subsidiary of TfL, owns the infrastructure of this line and franchises its operation to private companies (EMTA, 2004a p63). A concessionaire, Tramtrack Croydon Ltd, operates the Croydon Tramlink on behalf of Transport for London (TfL, 2004f).

TfL is a functional body of the Greater London Authority (GLA). GLA administers the area of Greater London, covering the 32 London Boroughs and the City of London. The authority consists of an elected Mayor and a 25-member Assembly (GLA, 2004 p vii; ONS, 2005). Therefore, TfL is accountable to the Mayor of London and is responsible for delivering the Mayor's transport strategy. It is directed by a management board whose members are appointed by the Mayor, who also chairs the board (TfL, 2004b).

Since the creation of Greater London as an administrative unit in 1965, the Greater London Council was responsible for running services such as public transport (through London Transport), the fire service, emergency planning and flood prevention throughout Greater London. After the abolishment of the Greater London Council in 1986, London Transport was taken over by the central government. London was so left without a central administrative body. Critics argued that this situation was chaotic and a new London-wide body was needed to coordinate the whole metropolitan area. In 2000, the new Greater London Authority was established. The mayor is now directly elected, instead of being elected by the boroughs' representatives, as was the case in the former Greater London Council (ONS, 2005). The GLA has responsibility for London's transport system via TfL and also, among other functions, for coordinating land-use and urban planning across the whole of Greater London. The individual London Borough Councils are legally bound to comply with the strategic land-use plan produced by the Mayor. He has the power to override planning decisions made by the Boroughs if it is believed that they were against the interests of London as a whole (Communities and Local Government, 2006 p15). Figure 7.2 summarises the main responsibilities of the Greater London Authority related with the transportation system.

**Figure 7.2: Spatial Coverage and Transportation-Related Responsibilities of the Greater London Authority**



TfL is funded by three sources of income. It receives revenue from its transport services (primarily bus and Tube fares) and grants from both Central Government and the Greater London Authority. TfL's total budget at the start of 2003/04 was £ 4,354 million (€ 6,700 million) of which revenue was 51 %, Government grants 48 % and the Greater London Authority grant 1 % (TfL, 2004b).

An interesting example that illustrates a coordinated transport policy in Greater London is the relation between the congestion charging scheme and the public transport improvements. The congestion charging scheme was designed to diminish congestion in the centre of the city (through a mandatory payment if a car enters the charging zone). But its design also considered the use of the incomes of the scheme to finance improvements in the public transport system, in order to give a better alternative to the persons who decide not to use the car because of the charge.

### 7.2.2 Berlin

The two main public transport operators in Berlin are the *Berliner Verkehrsbetriebe* (BVG) and the *S-Bahn Berlin GmbH* (S-Bahn). The BVG, a public company owned by the city of Berlin, operates all buses, metro and tram lines of the metropolitan area, together with some ferry services (BVG, 2004b), having more than 12,000 employees by the end of 2005 (BVG, 2005a). The S-Bahn is a private company totally owned by the *DB Regio AG*, part of the *Deutsche Bahn AG*, the former German public train operator which began a long privatisation process in 1994. It operated 16 suburban rail lines and had 3,800 employees in 2004 (SBB, 2005).

After the fall of the Wall, Berlin and the surrounding federal state (*Bundesland*) of Brandenburg were interested in coordinating public transport, in order to reconnect Berlin with its hinterland. In 1996 the *Verkehrsverbund Berlin-Brandenburg* (VBB) was founded. The VBB is a private company run by the Federal States of Berlin and Brandenburg, the 14 municipal districts (*Landkreise*) and 4 towns (*kreisfreie Städte*) of Brandenburg (EMTA, 2004a p102; VBB, 2004a). The VBB serves an area of 30,370 km<sup>2</sup> with more than 6 million inhabitants, i.e. much more than just the 892 km<sup>2</sup> and 3.4 million inhabitants of Berlin.

The *Verkehrsverbund* is a typical form of public transport authority used in the German speaking countries (Germany, Austria and Switzerland), which seeks coordination between public transport services under different political and administrative responsible bodies, for instance a metropolitan area and its surrounding towns, or several nearby cities. A *Verkehrsverbund* coordinates but does not own the public transport operations of their members. The first *Verkehrsverbund* was formed in Hamburg in 1965, and followed by Hannover (1970), Munich (1972), Frankfurt (1974), Stuttgart (1978), the Rhein-Ruhr region (including Düsseldorf, Dortmund, Essen, Wuppertal and Duisburg, 1980), Vienna (1985) and Zurich (1990), among many others (Pucher and Kurth, 1996 pp280-281). By 1997 there were 28 *Verkehrsverbünde* in Germany covering more than half of the population of the country (Hass-Klau et al., 1998 p31). These figures increased to nearly 60 *Verkehrsverbünde* covering 2/3 of the area and 80 % of the population of Germany by 2006 (Knieps, 2006 p41). The VBB is the largest German *Verkehrsverbund* in terms of area, but

the second largest in terms of population after the *Verkehrsverbund* Rhein-Ruhr, which had 7.2 million people in 2004 (VRR, 2006).

The main characteristics of a *Verkehrsverbund* are a unified fare structure, plus the coordination of timetables and services (Hass-Klau et al., 1998 p31), according to the maxim: one service-schedule, one fare, one ticket (Knieps, 2006 p40). Typically, a *Verkehrsverbund* is responsible for the introduction and development of an integrated fare system, the distribution of the fare incomes between the operators, the definition of general guidelines for the operation, the coordination of services, market research studies, users' information and advertising and public relations functions (Knieps, 2006 p42). On the other hand, the operators that are associated to a *Verkehrsverbund* are responsible for providing the services, controlling the specific details of how the services are provided: the types of vehicles, personnel, work schedules and maintenance.

Until the 1990s all the *Verkehrsverbände* were organised as a union of operators, but many of them changed into other organisational forms later (Knieps, 2006 p42), after the political responsibility for the regional rail services was transferred to the regions. So three different forms of organisation can be currently recognised in the *Verkehrsverbände* (Knieps, 2006 p41):

- A union of operators
- A union of responsible authorities
- A union of operators and responsible authorities (mixed systems)

Nevertheless, the user will not notice the distinct internal organisations of the *Verkehrsverbände*, because it does not make any important difference in the operation of public transport.

A *Verkehrsverbund* allows a clear separation of the political and entrepreneurial functions in the public transport system. The former are a responsibility of the federal states, municipal districts and towns that run the *Verkehrsverbund*, while the latter are a responsibility of the private and public companies that operate the services. The *Verkehrsverbund* undertakes the interface between them. Hence the political decisions become independent of the transport companies. This is known as the three-level-model, i.e. separated political, management and operating levels.

However, the VBB has important particularities that make it different to a typical *Verkehrsverbund*. Firstly, it has to be considered that during the cold war, West Berlin was completely isolated from West Germany, making suburbanisation impossible. On the other hand, East Berlin did not have a suburbanisation process either, because of a very strong political control of the housing locations by the East German government. Therefore, even several years after unification, the travel demand between Berlin and the Brandenburg region remained relatively low. Most of the trips in the VBB area are still inside Berlin or between Berlin and its immediate surroundings. Secondly, Berlin is not only by far the largest city in the VBB zone, but also the largest metropolitan area in the German speaking countries. It has therefore very special public transport needs. These special characteristics have as a consequence that the operators undertake some of the tasks that in other areas are undertaken by the *Verkehrsverbände*, as explained below.



According to some sources (EMTA, 2004a p103; VBB, 2004a) the main tasks of the VBB are:

- the coordination of the services run by the 45 public and private public transport companies and the improvement of the connections between them,
- the introduction and development of a common fare system for all companies in the VBB area,
- the improvement, standardisation and quality control of public transport services,
- users' information and
- assistance to the authorities in charge of public transport, for example, planning and ordering of regional railway services.

Nevertheless, all public transport services inside Berlin are directly planned and coordinated by the BVG and the S-Bahn, in concordance with the strategic transport plan developed by the city administration. Marketing and users' information tasks inside Berlin are also directly executed by the BVG and the S-Bahn, as well as the quality control of the services. The distribution of the fare revenues between the BVG and the S-Bahn is also defined by themselves through a contract. The VBB plays an important role in these tasks outside Berlin, in the Brandenburg Region, where it has to coordinate 43 public and private owned public transport companies (VBB, 2006a). In addition, the VBB is a key actor in the definition of the fare system and in the coordination of regional railway services in Brandenburg and Berlin. Compared with other Verkehrsverbände, it can be said that the VBB is a weak *Verkehrsverbund*, especially inside Berlin. A similar situation is found in other *Verkehrsverbände* for instance the *Verkehrsverbund Rhein-Ruhr* (VRR).

Berlin is administratively divided into 12 Boroughs and governed by the Senate of Berlin (*Senat von Berlin*) which consists of the governing mayor (*Regierender Bürgermeister*) and up to eight senators holding ministerial portfolios. The governing mayor is elected by the house of representatives (*Abgeordnetenhaus*) whose at least 130 members are directly elected by the inhabitants of Berlin. The governing mayor appoints the senators for Berlin. The mayors of each of the 12 Boroughs are subject to the supervision of the governing mayor (Berlin, 1995). The City Development Department (*Senatsverwaltung für Stadtentwicklung*) of the Senate of Berlin is responsible for all transport forms (public and private transport, non-motorised transport) and also urban planning and land-use. Together with the BVG and the S-Bahn, it develops the strategic transport plan which is the framework that delimits the actions of both public transport operators in Berlin.

An interesting example of the results of the *Verkehrsverbund* system in Berlin, as well as in other German speaking metropolitan areas, is the impressive fare integration. There are no modal-specific fares. On the contrary, the fare only depends on the origin and destination of the trip, without any restriction on public transport mode used or number of transfers made. In some regions the integrated fare system is even being expanded throughout different *Verkehrsverbände*, in order to reach regional-wide fare integration, e.g. the NRW-Tarif in the *Nordrhein-Westfalen* region (NRW, 2006). Furthermore, there is an integrated fare scheme between long-distance trains and urban public transport that allows travelling on all public transport modes inside the destination urban area using the same long-distance train ticket (DB, 2006), if the passengers has a train-frequent-traveller card (Bahncard 25/50). Although not massively used, there is even a national-wide integrated fare in Germany through a

travelcard (BahnCard 100) that allows unlimited use of all trains (including long distance intercity trains) and also unlimited use of urban public transport in all major metropolitan areas (DB, 2006). A similar national-wide integrated travelcard called General-Abo exists in Switzerland (SBB-CFF-FFS, 2006).

### 7.2.3 Madrid

Madrid is the name of both the capital city of Spain and its region. Madrid Region (*Comunidad de Madrid*) is formed by 179 municipalities, one of which is Madrid City. During the 1970s and 80s national, regional and municipal authorities had partial responsibilities of the public transport system, which was operated both by public and private concessionaire companies. As a result there was a lack of coordination in the infrastructure, route, frequency and schedule design of the public transport services (CRTM, 1990 pp4-5).

In order to solve these coordination problems, a public transport authority called *Consortio Regional de Transportes de Madrid* (CRTM) was created in 1985. CRTM is an autonomous agency of the regional government that includes the public transport responsibilities of the region and the joined municipalities. A regional subsidy has worked as an incentive to join CRTM for the municipalities of the region<sup>5</sup> which have been joining the authority throughout the years (Cristóbal-Pinto, 2005). 175 of the 179 municipalities of the region had adhered to CRTM at the end of 2002 (CRTM, 2004a). CRTM regulates and coordinates the services, but both public and private companies keep their independent management (CRTM, 1990 p7). The main functions of CRTM are (Cristóbal-Pinto, 2002):

- the planning of transport services and definition of coordinate operating programmes for all public transport modes,
- the establishment of an integrated fare system for all the public transport system,
- the planning of public transport infrastructures and
- the creation of an overall image for the public transport system, being CRTM who holds the external relation with the users.

The similarity in functions between a typical *Verkehrsverbund* and CRTM is striking.

The public transport system of Madrid Region is mainly based on four transport modes: two urban modes (metro and urban buses) and two suburban modes (buses and rail). In 2002, there were 36 public transport operators: *Metro de Madrid*, which operates the underground system, is a public company owned by the Madrid Municipality (75 %) and Madrid Region (25 %); *Empresa Municipal de Transportes de Madrid* (EMT), which operates bus services in Madrid City, is wholly owned by the Madrid Municipality; *Cercanías-Renfe*, a public company dependent on the Spanish public works ministry, operates suburban rail services; and 33 private companies operate the suburban bus services (CRTM, 2005 p5).

CRTM has authority over the metro, urban bus and suburban bus operators, because their respective responsible bodies (Municipalities and Madrid Region) are part of CRTM. On the

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<sup>5</sup> CRTM negotiates and comes to agreements with various administrative bodies to obtain the subsidies that supplement fare revenues in financing the system (CRTM, 2005 p7). In 2003 the operational subsidy was mainly financed by the regional government of Madrid (62 %) and the national government (21 %). The access to these funds has acted as an incentive for the municipalities to join CRTM.

other hand, although CRTM has no authority over the commuter rail operator *Cercanías-Renfe*, both parties have a fare integration agreement that regulates the use of an intermodal travelcard (CRTM, 2005 p1).

CRTM manages the major part of the fare incomes. However single tickets revenues go directly to Metro de Madrid and EMT respectively, and the revenue of both single tickets and multiple trips coupons goes directly to the suburban modes (EMTA, 2004a p67).

CRTM's management board is formed by representatives of (CRTM, 2005 p1):

- the regional government (5)
- the municipality of Madrid City (5),
- other associated municipalities (8),
- the Spanish government (2),
- the transport operators (2),
- trade unions (2) and
- users and consumers associations (1).

The president of the management board and CRTM is one of the delegates of the regional government, while the vice president is one of the representatives of the municipalities (CRTM, 1990 p13). CRTM had some 120 staff members in 2002 (EMTA, 2004a p65).

Three decision-making levels (national, regional and municipal) can be clearly recognised in Spain. At the lower level, the municipality of Madrid has a directly elected house of representatives and a mayor. The first representative of each list may be elected mayor by the house of representatives, but if no one has more than 50 % of the representatives' votes, then the first representative of the list that received more votes from the people is elected mayor (Spain, 1985). The regional government (*Comunidad de Madrid*) also has a directly elected house of representatives that elects the president of the region (MAP, 2006), who appoints 13 regional ministers. Both the region and the municipalities have public transport responsibilities, which have been transferred to CRTM. Nevertheless, the final political responsibility on public transport is still divided among the president of the region and the mayors of the municipalities. The coordination problems that the absence of a metropolitan political authority causes in the public transport system are interestingly solved through CRTM. On the other hand, the private transport (roads) responsibilities remain in different authorities (central government, regional government and municipalities), as is the case with the land-use definitions which are a responsibility of the regional and municipal governments (MAP, 2006). In fact, private transport and land-use responsibilities were not transferred to CRTM. This may cause coordination difficulties in those areas.

Two examples of the success of the system in Madrid are presented next:

1. Firstly, one of the most interesting examples of the integrated public transport policy of CRTM is the introduction of a travelcard called "*abono de transportes*", which allows unlimited use of all the public transport modes. 33 % of all the public transport trips were made using this travelcard in 1989. In 2003, this amount had increased to 64.5 % (CRTM, 2004f p48).
2. Highly impressive is the drastic change in the demand tendency after the creation of CRTM in 1985. Between 1974 and 1986, the yearly public transport patronage in

Madrid Region dropped more than 50 % from 1,184 to 950 million trips. Between 1986 and 2003, the demand had increased more than 60 % to 1,544 million trips (CRTM, 2005 p1). The coordinating efforts of CRTM are one of the main explanations for this success.

### 7.3 Comparison and Discussion of the Public Transport Authorities of London, Berlin, Madrid and Santiago

The following figures summarise the main characteristics of the public transport authorities in the four reviewed capital cities. Figure 7.3 shows the single political authority responsible for the public transport, whereas figure 7.4 presents the public transport authority of every European metropolitan area and their responsibilities.

The public transport institutional organisation in Santiago de Chile has been changing over the time, as the general institutional organisation of the capital city and the country changed. But a specific organisation that directly responds to the problems of the public transport system has not been designed yet. On the contrary, as the absence of coordinated policies has become evident, the response has been to create new bodies (SECTRA, Transantiago) with the aim of coordinating the existing agencies. Nevertheless, the actual responsibilities and budgetary control have remained in the former institutions, so that the coordination becomes very difficult in the medium and long term.

**Figure 7.3: Single Political Authority Responsible for Public Transport in the Metropolitan Areas**

	Gran Santiago	Greater London	Berlin	Madrid
Post:	Transport minister (among others)	Mayor	Governing mayor ( <i>Regierender Bürgermeister</i> )	Mayor
Is elected or appointed by:	President of the country	Direct election (inhabitants)	130 members house of representatives	House of representatives of the municipality

**Figure 7.4: Main Distinctive Characteristics of the Technical Transport Authorities in London, Berlin and Madrid**

	London	Madrid	Berlin	
has a	transport authority	public transport authority	public transport authority	and two public transport operators
called	Transport for London	Consortio Regional de Transportes de Madrid	Verkehrsverbund Berlin-Brandenburg	BVG and S-Bahn
responsible for	public, private and non-motorised transport	public transport	public transport	public transport
covering	Greater London	Madrid City	<i>Berlin</i> <sup>(a)</sup>	Berlin <sup>(a)</sup>
and the region of	-----	Madrid Region	Brandenburg	-----

<sup>(a)</sup> The *Verkehrsverbund* Berlin-Brandenburg has limited powers inside Berlin, where the planning, coordination, etc. of the public transport system is directly made by the two operators (BVG and S-Bahn).

A similar situation is described by Gwilliam (1999) for the metropolitan area of Bangkok, where 27 different agencies having some form of transport responsibility exist. There, another agency was established to coordinate the plans of the other agencies, but this had relatively little impact, because the new agency had no effective budgetary control or influence. Gwilliam argues that it is difficult to seek the establishment of multi-jurisdictional, multi-modal transport planning and regulation agencies at the conurbation level, in the absence of more comprehensive reform of local government organisation.

It could be argued that this was exactly what Greater London did in 2000, when the new Greater London Authority (GLA) was created, taking over responsibilities from the London Boroughs and the central government. However the creation of GLA is much better described as a *turning back* into a citywide authority. Indeed, a Greater-London-wide authority called Greater London Council already existed until 1986, after replacing in 1965 the previous London County Council (LCC) that covered a smaller area. The LCC was the first London-wide elected authority, covering what is today known as Inner-London (Saint, 1989). It was created in 1889 and replaced the Metropolitan Board of Works, an appointed rather than elected body that was created in 1855 after London's growth rapidly accelerated with the increase in railway commuting from the 1830s onwards, making London's local government chaotic, with hundreds of specialist authorities with partial responsibilities (Owen, 1982). London is a good example that shows that in a Metropolitan Area an

area-wide transport agency is necessary to achieve the objectives of fare integration and coordination of public transport modes and infrastructure.

London has a more than 100-year-old history of elected citywide authorities, with an interruption between 1986 and 2000. On the contrary, Santiago has never had a citywide authority, but a regional authority (*intendente*) accounted by the president of the country and elected mayors in every one of the more than 30 municipalities in which the metropolitan area is divided. The creation of a citywide (metropolitan) authority has been proposed elsewhere, but has never been seriously considered by the decision-makers so far.

Two aspects of the Greater London Authority are especially interesting for a transportation analysis. Firstly, the mayor is accountable for both the planning and delivery of transport facilities. And secondly, beside the public transport responsibility, the mayor is also accountable for the road system (private transport) and the urban planning. The latter is very important because changes in the road capacity used by private cars affect the public transport demand (see Appendix A). Moreover, the interactions between transport system and land-use and the importance of a joint transportation and urban planning are well-known (see for example EMTA, 2000 p5).

Unlike London, Madrid created a public transport authority (*Consortio Regional de Transportes de Madrid*, CRTM) without any other political powers. CRTM only has responsibilities related with the public transport system, which are transferred to it from the regional and municipal authorities that join CRTM, and is managed by a board formed by representatives of the regional government, municipalities and operators, among others. This institutional design is a response to the disseminated responsibilities in public transport, which are spread out between the regional and municipal authorities. It also recognises that the relevant area for the urban public transport organisation is in this case wider than just the municipality of Madrid. For this model to succeed, it is necessary that many local governments voluntarily join CRTM. The regional subsidies for the public transport system have act as an incentive for the municipalities to join CRTM.

The scheme used in Madrid is probably inspired in the public transport authority typically found in the German speaking countries, the *Verkehrsverbund*. Also being responsible for the public transport coordination in areas with different local or regional authorities, the *Verkehrsverbund* can be organised as a union of responsible authorities, a union of operators or a union of both responsible authorities and operators. In the case of the *Verkehrsverbund Berlin-Brandenburg* (VBB), it corresponds to a union of responsible authorities: those 2 federal states and all the municipal districts and towns of the Brandenburg region.

The VBB, being a private company, is actually owned by the regional and local governments. This is the difference to CRTM, which is managed by a board that, beside regional and local representatives, also includes representatives from the national government and from the operators, trade unions and consumer associations.

Another important difference is that only the regional government and the municipality of Madrid initially formed CRTM. The idea was that other municipalities joined CRTM afterwards, which effectively occurred. So, CRTM has been growing, in terms of the number

of municipalities adhered. On the contrary, VBB and the *Verkehrsverbände* in German speaking countries in general, are designed from the beginning with their definitive spatial shape.

But the most important difference between CRTM and VBB is that CRTM has a much stronger power in the definition of public transport services than the VBB. In Berlin, the two public operators (BVG and S-Bahn) directly plan and coordinate their services, in concordance with the strategic transport plan of Berlin. They are also directly responsible for marketing and users' information. The VBB assumes these tasks mainly outside Berlin in the Brandenburg region. On the contrary, CRTM is the main agent for planning and coordinating public transport services inside Madrid City, and also in the rest of the region. Marketing and users' information tasks are also a direct responsibility of CRTM and not of the operators.

Particularly interesting is that, in spite of having different institutional organisations and powers, the distinct public transport authorities (in Berlin and especially in London, and Madrid) have common responsibilities regarding the public transport system. The most important of them are (figure 7.5):

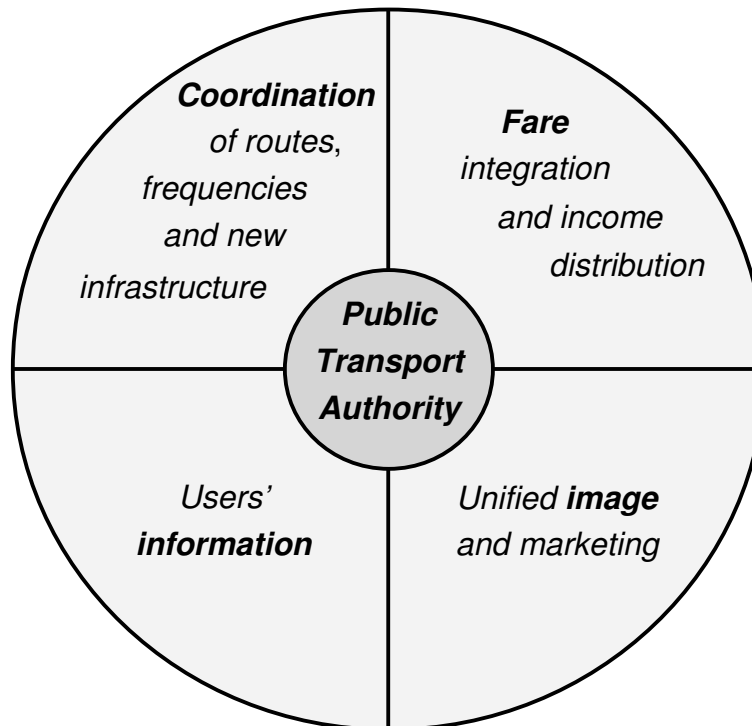
- Coordination of public transport services: the design of coordinated routes and timetables, together with the planning of new infrastructures.
- Integrated fare system: the development and introduction of integrated payment systems (e.g. travelcards) and fare structures (fare zones, etc.), and the distribution of fare incomes and subsidies between the operators.
- Users' information: publication of maps, timetables, fare information, etc. Development and implementation of tools to facilitate the use of public transport.
- Unified image and marketing of the public transport system: the creation and management of a unified image for the entire public transport system, regardless of how many different operators there are, and marketing and promotion of the public transport.

The new integrated public transport system that is being implemented in Santiago (*Transantiago*) has been designed considering all the major objectives regarding public transport that are common to the public transport authorities in London, Berlin and Madrid. In fact, instead of the previous competing routes, complementary bus routes were designed in order to have coordination between bus lines and metro. Moreover, an integrated fare system was designed together with a users' information system that was tendered to a private company during 2006.

However, the public agency that was specially created to coordinate the implementation of the plan (*Transantiago*) as the executive body of an inter-ministerial commission will probably be transformed into an agency of the ministry for transport and telecommunications (MTT), after the system is fully implemented by the beginning of 2007. Its main tasks will be the management and control of the contracts with the private companies responsible for the operation of the system (bus operation and finance and information management). This implies that no relevant change will be made in the institutional organisation, and that this agency will not have any new attributes, but only the responsibilities that the MTT already had. Budgetary control (e.g. for new public transport infrastructures) will remain spread out between different governmental agencies. It is questionable whether this form of

organisation will be capable of further improving the public transport system of Santiago. But at least there will be a special agency with specific dedication to the public transport system, something that did not exist before.

**Figure 7.5: Main Responsibilities of a Public Transport Authority**



## 7.4 Recommendations for Santiago and Conclusions

The way in which a transport authority is organised is necessarily a response to the own administrative structure of that particular metropolitan area, the laws of the country, the financing models and its history. This is one of the conclusions after reviewing London, Berlin and Madrid. Therefore, the recommendation for Santiago cannot be just a copy of one of these cases. On the contrary, the best practices found in the European cases have to be adapted to the particular (administrative, political, etc.) conditions in Santiago.

Two types of public transport authorities could be recognised in the analysis of the three European cities. In Berlin and Madrid the name "Public Transport Authority" is the most appropriate, because the authorities are only responsible for public transport issues. On the other hand, Greater London has a wider authority which is also responsible for private and non-motorised transport issues and urban planning in the metropolitan area (in addition to other responsibilities outside the transportation area). In this case the name "Transport Authority" (or even "Metropolitan Authority") is more adequate. But in terms of public transport, this authority has mainly the same tasks as the public transport authorities in Berlin and Madrid (see figure 7.5). Another positive aspect of the transport authority in Greater London is that it unifies planning and execution responsibilities. In the cases of Berlin and Madrid it is interesting that the public transport authorities cover not only the main urban area, but also the suburban area surrounding it. Also interesting in the case of Madrid



is that the spatial coverage of the public transport authority was expanded through the years. A negative characteristic in the case of Madrid is a more difficult coordination between public transport and private transport policies due to the specialisation of CRTM in public transport issues. A summary of the main distinctive characteristics of the three European authorities was presented in figure 7.4.

Although the public transport authorities of Berlin and especially Madrid are regarded as positive experiences, the transport authority of Greater London seems to have a more interesting institutional organisation, mainly because of the wider scope of the authority (e.g. private and non-motorised transport). But the implementation of a London-like transport authority in Santiago would imply an important institutional change, as already explained, which would be difficult to implement and would probably take a long time to be achieved. Therefore, a two-step institutional change for Santiago seems to be the logical proposition at this point: as a first-step, a public transport authority (like in Madrid), and in the medium and long-term a transport (metropolitan) authority. However, as we will discuss below, the first-step public transport authority is not really an interesting solution for Santiago.

#### **7.4.1 About a public transport authority for Santiago, similar to the solutions in Madrid and Berlin**

In Madrid and Berlin a new body was formed to coordinate public transport issues between the existing actors. But unlike the analysed cases of Madrid and Berlin, the local municipalities in Santiago have almost no responsibilities in public transportation. There are no municipal public transport companies (metro is owned by the national state and bus companies are private), and the concession of the bus services are not given by the municipalities, but by the central government. The coordination of public transport services for which different local authorities are responsible is one of the main tasks of the public transport authorities in Berlin and Madrid. But in Santiago these responsibilities are not spread over different local authorities, but over different central government agencies!

Therefore, trying to follow the objectives of the public transport authorities of Madrid and Berlin, the logical recommendation for Santiago would be that the central government should form an agency specialised in public transport themes for Santiago, and that **all other agencies should transfer their public transport responsibilities to this agency**. Which are the main tasks that this agency should face? Those described in figure 7.5, which are the common public transport responsibilities not only of the public transport authorities in Madrid and Berlin, but also of the transport authority of London: coordination of frequencies, routes and infrastructure development for all public transport modes, the implementation of an integrated fare, providing users' information and being responsible for a unified image and marketing for the public transport system.

The coordinating agency Transantiago, as explained above, introduced a public transport plan that considers all those major objectives. Though, after the implementation of the plan, **the agency will not receive any public transport responsibilities from other agencies**, implying that the coordination difficulties between central government bodies will surely continue. What can be done in order to improve that coordination in the absence of a wider transport authority? Indeed, only huge coordination efforts can help. Coordination has to be

sought with planning bodies (e.g. SECTRA), the authorities responsible for the infrastructure construction (ministries for public works and for housing and urban planning) and metro.

But this seems to be not enough to assure an adequate future development of the public transport system in Santiago. Coordination between different institutions has shown to be particularly difficult in the case of the public transport system of Santiago. Therefore, a better solution for Santiago is needed.

#### **7.4.2 A regional transport authority for Santiago's metropolitan region**

Though implying a difficult institutional change that would take several years to be completed, the most suitable solution for the institutional design that is needed for the public transport system and the transport system in general in Santiago seems to be the creation of a regional transport authority, as will be explained next.

The term "transport authority" can refer to two related concepts, which have to be distinguished: firstly, the political authority that is responsible for transport issues, and secondly its technical and administrative office, which is in charge of implementing the policies and plans defined by the political authority and assists it in the creation of these plans. In what follows, a proposition for a new political transport authority for Santiago is described.

A political citywide transport authority for Santiago should have all the responsibilities related with the public transport system, and should also be responsible for the private transport system and urban planning. In addition, it should be responsible for both the planning and implementation of those policies, plans and projects. Given that this authority should have important decision-making powers and control over an important budget, it is recommended to be a directly elected authority, so that it can regularly be approved/disapproved by the community. In order to establish this authority, a comprehensive reform of the local government organisation is needed.

##### **Spatial coverage**

As in London, this authority could have a spatial coverage corresponding to the complete city (Greater London). In the case of Santiago, this could be the urban limit, which is called *Gran Santiago*. However, this limit changes from time to time as the metropolitan area grows. It has to be taken into account that Santiago has been growing faster than Greater London in terms of population in the last decades (see figure 6.1). In addition, although most of the trips are made inside those boundaries, there are commuter trips that cross those boundaries to other cities or towns of the region. Finally, and probably the most important fact, there are no institutional bodies corresponding to that urban limit. This would make such an institutional change especially difficult and slow. On the contrary, a regional authority already exists and this institution could be used as a starting point for the creation of the transport authority proposed here (although in practice the regional government has no influence in transportation issues).

In comparison with a metropolitan citywide transport authority, the proposition of a regional transport authority has two advantages. Firstly, given the fact that Santiago is a spatial growing metropolitan area, the region is wide enough to include all the area that is currently relevant for urban transportation, and also the areas that are expected to become relevant in the future, i.e. that are expected to be part of *Gran Santiago*. In addition, it also covers most of the relevant towns and cities in terms of suburban trips to/from Santiago (e.g. Talagante, Colina, Melipilla, Buin). The regional area is shown in figure 7.1, where the area covered by *Gran Santiago* is marked with a circle. Although the region has a much larger area (15,100 km<sup>2</sup>) than *Gran Santiago* (648 km<sup>2</sup>), the population of the region outside *Gran Santiago* is just about 500,000 inhabitants, i.e. less than 10 % of the population of *Gran Santiago*. In comparison, the regions of Berlin and Brandenburg have an area of more than 30,000 km<sup>2</sup> with approximately 45 % of the population living outside Berlin, and Madrid Region has 8,000 km<sup>2</sup> and also 45 % of the inhabitants live outside Madrid City (table 6.1).

### **Responsibilities and organisation**

All public transport responsibilities should be transferred from the ministry for transport and telecommunications (MTT) to the regional authority. These responsibilities are mainly in the regional secretaries of the MTT, so that they are already separated by region. By doing so, the new authority responsible for public transport issues in the region would be the *intendente* instead of the ministry (and through it the president of the country) as it is today.

The Traffic Control Operative Unit (UOCT) described at the beginning of this chapter (section 7.1.2) should be transferred from the transportation ministry to the regional transport authority. This would be no problem, as it has only responsibilities inside Santiago. However, it should maintain professional contact with other traffic control units in other Chilean areas (currently also depending on the transport ministry), something that would naturally happen due to the similarity of their functions.

In addition, private transport (roads) responsibilities mainly from the ministry for public works should also be transferred to the regional government, and the same should occur with urban planning responsibilities from the ministry for housing and urban planning. Again, for the most part these responsibilities are already in the regional secretaries of these ministries. But there is one important exception: the responsibility for the urban highways that were constructed through a public-private partnership (PPP) in the last years and the (eventual) planning of further urban highways. The design of these projects and the concession to the private sector were managed by a special unit of the ministry for public works, called "*Coordinación de Concesiones*". This body was firstly created to implement interurban highways along Chile through PPPs, and therefore it has a national scope. Later it also implemented the urban highways inside Santiago<sup>6</sup> shown in figure 2.5. Both the design of new infrastructure for the private car and the management of the contracts with the private companies that operate the already existing concessions have to be transferred to the new regional transport authority. To do that, *Coordinación de Concesiones* would need to be split, at least in terms of its planning groups. This is a very important aspect, because in the past the planning, the design and the decision of building those urban highways were made in absence of a wider view of the complete transport system of the metropolitan area. This has

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<sup>6</sup> Currently, in addition to the implementation of transport infrastructure it is also in charge of the construction of prisons in different regions of Chile, among other projects (always through PPPs).

been a deep problem and represents one of the best examples showing the necessity of a unified transport authority for Santiago. These decisions have to be transferred to the regional transport authority in order to assure a coordinated planning of all the transport system.

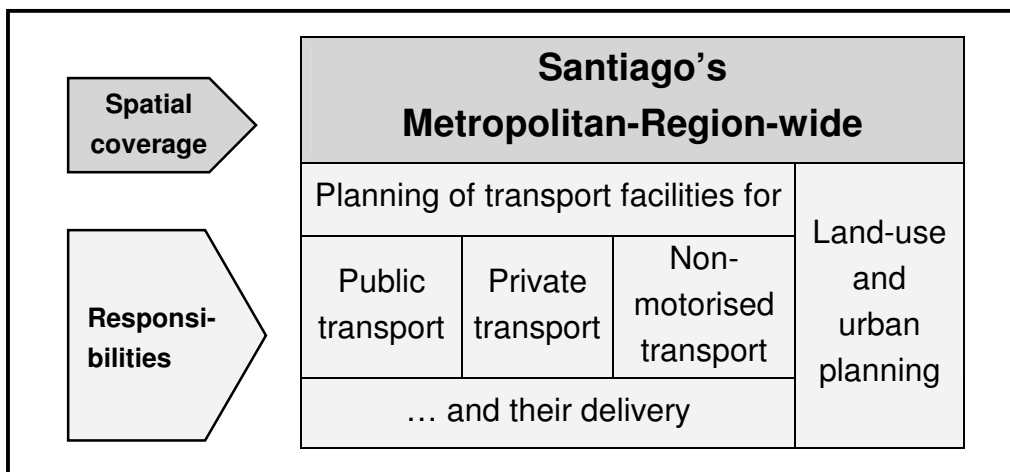
Other responsibilities related with non-transport issues could also been transferred to the regional government, but that is beyond the scope of this research (see SUBDERE, 2000 p20).

There are other national-wide transportation-related agencies that would need to be incorporated to the regional transport authority. This is the case of the two technical offices SECTRA and CONASET (described in section 7.1.5). But these bodies do not have any responsibility in deciding about the final implementation of the projects they help to plan. In the author's opinion, there would not be any problem for a coordinated work between them and the regional transport authority, even if they remain concentrated at a national level depending on the central government. There should be some form of association between the regional transport authority and these agencies stating the terms of their cooperation with the regional authority. Moreover, the high specialisation of these bodies makes it better to maintain them as a national-wide body. The creation of separate agencies for every metropolitan area in Chile would imply an unnecessary duplication of offices needing the same very specific know-how (transportation modelling, transportation surveys, etc.).

The municipalities would continue existing as they are, and actually no relevant changes in their institutional organisation or their functions seem to be needed, at least in terms of public transport issues, as they do not have important responsibilities in that field. Of course, their decisions would have to be coherent with the citywide and regional decisions of the regional authority, but this is already so (e.g. urban planning and land-use).

Figure 7.6 summarises the transportation responsibilities of the proposed regional authority. Like the authority of Greater London, it is accountable for the planning and delivery of public, private and non-motorised transport, together with land-use and urban planning. But unlike the Greater London Authority and similar to the public transport authorities in Berlin and Madrid, it has a wider spatial coverage, including not only *Gran Santiago* but the complete region.

**Figure 7.6: Spatial Coverage and Transportation Related Responsibilities of the Proposed Regional Authority for Santiago**



Visual representations of the current and proposed institutional organisation of the transport system in Santiago are presented in figure 7.7 and figure 7.8. These are simplified and non-exhaustive representations that show the main actors of the decision-making process in transportation issues and allow a visual comparison of the current and proposed organisations.

### **Election of the political authority**

Currently, the regional authority consists of a regional *intendente* and a set of delegates. None of them are directly elected: the *intendente* is appointed by the president of the country, and the delegates are elected by the communal representatives elected by the population. In the author's opinion, the regional government should not be appointed by the president of the country, but elected by the inhabitants of the region. It has to be taken into account that he would have control over an important budget and a much more important decision-making power than today.

A first attempt in this direction was being discussed in the national parliament, in order to directly elect the representatives of the regional government (El Mostrador, 2004). This would be a positive change in the direction of a regional transport authority. After that, the appointment of the *intendente* should be improved, being elected either by the representatives or directly by the population. Through these modifications, the *intendente* would not be a regional representative of the president anymore and the regional government would become a representative authority of the region.

### **Further discussion**

The fact that a regional government already exists makes the necessary institutional changes much easier than they would be in the case of the creation of a completely new metropolitan citywide transport authority. However, important institutional changes are still needed to convert the current regional authority into a transport authority. This process is expected to be difficult and slow. It would be a major change in the general institutional and political organisation of the metropolitan area. An agreement of the political forces of the country would be needed, as a modification of the law would be necessary for its implementation. An elected regional authority for Santiago would certainly become the second most important political figure of the country, after the president. This would imply a change in the whole political scheme of Chile, and probably not all political forces will concur with the idea of creating such an important political post. Short-term political interests may be contrary to it.

An important advantage is that there are elsewhere propositions to improve the regional government in terms of both its appointment procedure and the transferring to it of regional tasks that are currently responsibilities of the national government (SUBDERE, 2000 p20). Although these proposals are mainly focussed on issues other than the transport system, they are perfectly complementary to the transportation analysis made here. But this is by far not enough to assure that those changes will effectively happen.

Although most of the transportation experts concur with the necessity of a transport authority for Santiago, this has neither been a relevant issue for the public opinion nor for the politicians in the last decades. Therefore, this problem needs to be transformed into a *relevant* issue in Santiago first. As an example, in the presidential election of 1999 both most voted candidates included in their programmes the creation of a transport authority for Santiago. However, this was surely a recommendation of their transportation experts that was not politically interesting for them. In fact, the elected government did not make any attempt to introduce a change in that direction during the presidential period, and the opposition did not make any complain because of the not fulfilled (shared) campaign promise.

But there is currently one punctual event that may help converting the necessity of a transport authority (or at least a public transport authority) into a relevant political issue. With the start of *Transantiago*, the authority will have to take care of many new tasks in terms of management of the public transport. Although the operation is still in private hands, the new organisation of the system needs a more active role of the authority in supervising the fulfilment of conditions defined in the contracts, optimising routes and frequencies, creating new services in the future, among others<sup>7</sup>. For example, an interestingly aspect is that the contracts consider guarantees for the bus operators if the travelling speed of their buses decreases because of bad traffic conditions. Thus the authority will have to monitor these conditions and will have to design and implement measures to avoid buses to be affected by congestion. This fact seems to have been recognised by the transport ministry, who has mention (in the press) an eventual interest in creating a public transport authority several times in the last months previous to the start of *Transantiago*.

Probably the most difficult aspect of the here-proposed regional transport authority would be the change in the election system of the authority. As discussed above, there can be no certainty about the existence of the necessary political consensus to create such a strong new political figure. It could take many years for this agreement to occur. But it is not possible to wait indefinitely to improve the institutional organisation of the transport system in Santiago. Therefore, if there is really a political interest in generating a (public) transport authority, this should be done following the characteristics of the here-proposed authority, even if no change in the appointment of the regional authorities is expected to happen. But it has to be taken into account that a regional authority appointed by the president will never have a comparable political weight to the one of an elected authority. There are at least two relevant aspects that make an appointed regional authority weaker than an elected one: firstly, the president can remove him at any time, and secondly, he will not have more political weight than the ministers, which are also appointed by the president. Therefore, if an appointed regional transport authority exists, it cannot be discarded that in case of future disagreements between him and some ministers, the president would have to enter the discussion and decide, perhaps against the position of the regional authority. So the president would still be the final political transport authority. This could not happen if the regional authority were elected by the inhabitants of the region.

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<sup>7</sup> All this drastically contrasts with the previous practical responsibilities of the authority in the bus system, which were no further than tendering the operation and making some very basic enforcement of operational conditions (for instance frequencies were not controlled in practice).

One negative aspect of the proposed democratically elected regional transport authority would be the predictable accentuation of the use of new transportation projects (e.g. new metro lines and urban highways) as campaign promises. This would make it even more difficult to include technical considerations in those decisions. Currently, transportation projects are secondary topics in presidential campaigns, because they are rather local given the national character of the election.

The institutional problems discussed in this chapter for the case of Santiago are also present (in a somewhat lower extent) in the other large Chilean conurbations *Gran Concepción* and *Gran Valparaíso*. Therefore, if a regional transport authority is created for Santiago, there will be an interest in simultaneously creating similar authorities for the other conurbations. This could make the change a little more complicated because of the different characteristics and needs of a large metropolis like Santiago (with almost 6 million inhabitants) and the other much smaller conurbations (with something more than a half million inhabitants).

Finally, a democratically elected regional authority would have other responsibilities outside the transport system. This would make the new institutional design more complicated, because the responsibilities in other fields would also have to be analysed and incorporated. Being beyond the scope of this research, fortunately there are proposals elsewhere for the transfer of responsibilities in other areas to the regional government, as discussed above.

### 7.4.3 Conclusions

The absence of a public transport authority in Santiago was detected to be a key problem. Based on the analysis of the European experiences in this field a recommendation for Santiago was drawn.

The three European metropolitan areas analysed present different institutional solutions for the organisation of its transport system. Transport for London (TfL) is the local authority responsible for nearly all issues of transportation in Greater London. Interestingly, TfL is responsible not only for public transport issues, but also for many aspects of the private transport system and non-motorised modes. TfL manages all public transport modes inside Greater London, except national rail services<sup>8</sup>. In addition, TfL manages the main roads and all traffic lights in Greater London, runs the central London congestion-charging scheme and regulates taxis. TfL also undertakes works in order to improve conditions for walkers and cyclists. TfL is accountable to the Mayor of London who is not only responsible for transportation issues but also for urban planning and land-use definitions.

*Consortio Regional de Transportes de Madrid* (CRTM) is the local authority responsible for the public transport system not only in Madrid City but also in the rest of Madrid Region. CRTM is responsible for the planning and coordination of all public transport modes, but it has no responsibilities related with private transport and non-motorised modes. CRTM is an autonomous agency of the Regional Government (*Comunidad de Madrid*). At the end of 2004, 176 of the 179 Municipalities of Madrid Region, representing practically the entire population of the region, belonged to CRTM.

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<sup>8</sup> TfL established a partnership with the Strategic Rail Authority. Moreover, the responsibility for the management of the North London Railway will be transferred to TfL by 2007.

A public transport authority called *Verkehrsverbund Berlin-Brandenburg* (VBB) exists in Berlin and the surrounding region of Brandenburg. As the CRTM in Madrid, the VBB is responsible for public transport issues without having any responsibility on private transport and non-motorised modes. But unlike the powerful CRTM, the VBB has only a secondary role inside Berlin, where the planning and coordination tasks are handled by the two operators themselves, in direct coordination with the city administration. The two main operators in the public transport system of Berlin are the *Berliner Verkehrsbetriebe* (BVG) and the *S-Bahn Berlin GmbH* (S-Bahn). The BVG operates buses, underground, trams and ferry services, whereas the S-Bahn operates the suburban rail.

Currently, the president of Chile is the political transport authority in Santiago as he is the only elected authority accountable for the complete metropolitan area. No technical body widely responsible for all public transport issues exists. However, having studied some examples of international experiences, a citywide or metropolitan authority seems to be more suitable than a countrywide authority to handle the transportation issues in a large metropolitan area. In addition, a technical transport authority is needed in Santiago.

In terms of public transport the transport authority in Santiago should be responsible for the following tasks which are common to all analysed European public transport authorities:

1. The planning and coordination of public transport services.
2. The development of a common fare system for all public transport services and the distribution of its revenues between the operators.
3. The provision of users' information.
4. The creation of a unified image for the complete public transport system and its marketing.

Taking into account the particular administrative structures in Santiago, the most suitable solution for the institutional design that is needed for its public transport and its transport system in general is the creation of a regional transport authority. In terms of the transport system, this authority should be responsible for the planning and implementation of both public and private transport policies, plans and projects. It should also be responsible for the non-motorised modes and for urban planning and land-use definitions at the regional level. The different central government agencies that have urban transport responsibilities should transfer them to this regional authority. Also responsibilities from other areas different to the transportation could be transferred to the regional authority, as long as they have a regional scope, but that is beyond the analyses of this research. The regional government should change its appointment system in the direction of directly elected head and representatives.

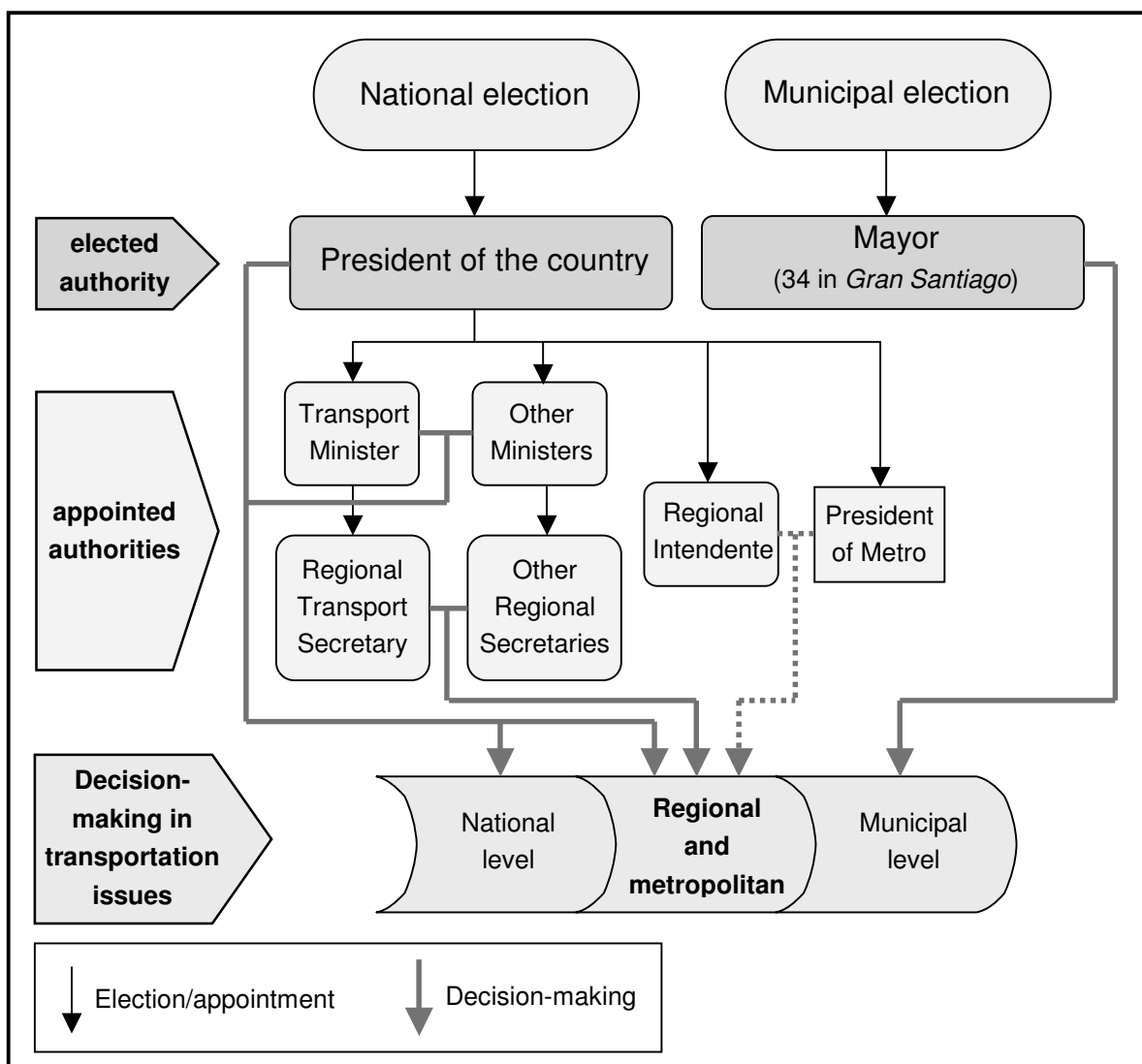
It is worth mentioning that this proposal takes into account the four aspects that the Association of European Metropolitan Transport Authorities recommends, including fields outside the sphere of public transport (EMTA, 2000 p5), in order to be able to offer travellers an integrated transport system: (1) a relevant territory has to be considered, encompassing all the trips of people in the metropolitan area, (2) an integrated public transport system has to be provided offering travellers a real network, (3) an integrated approach for public transport and other modes is necessary, especially in relationship with private car policies



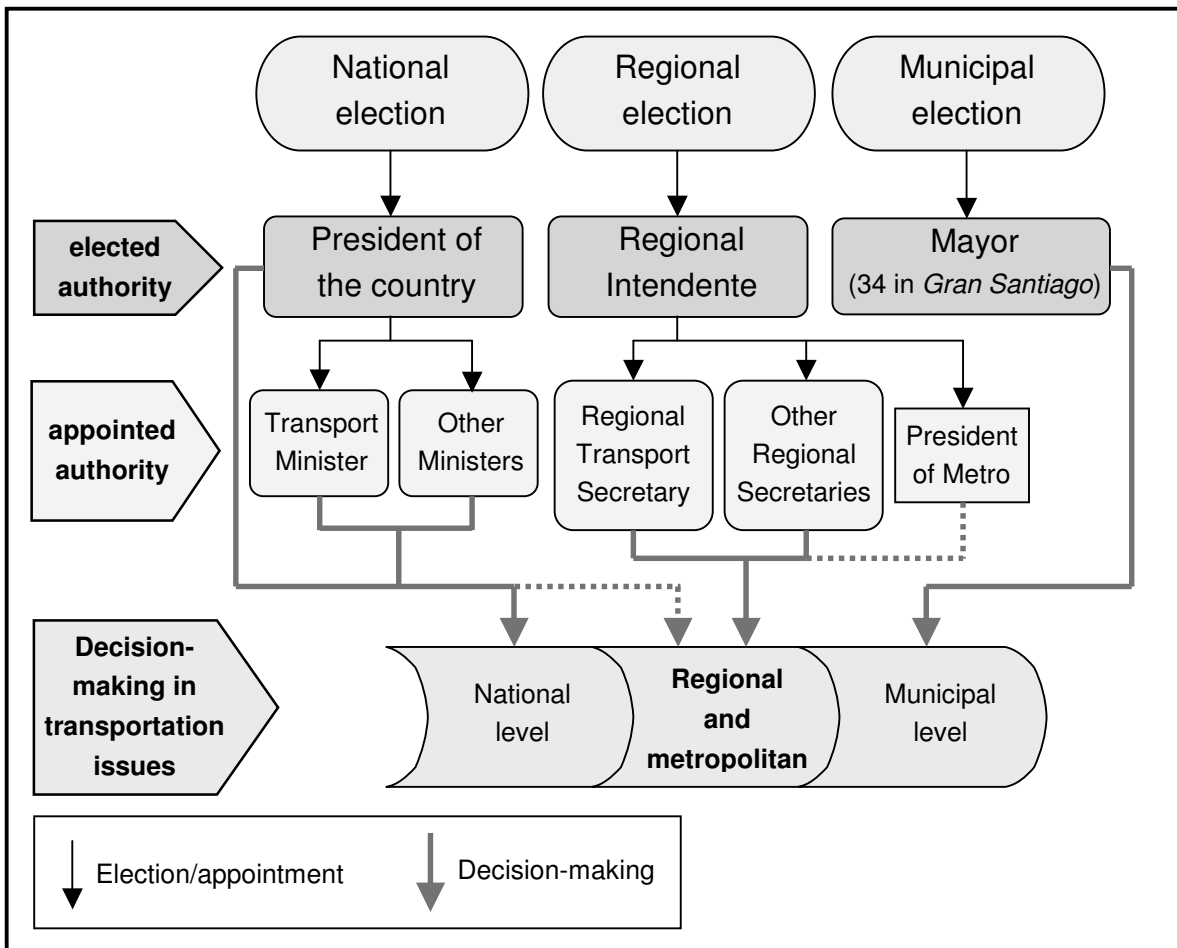
and (4) an integrated approach for transport issues and urban planning is necessary, taking into account the impact on mobility and on transport modal shift of new urban developments.

Several difficulties for the full implementation of a democratically elected regional transport authority were detected. The most important is the absence of political interest in the problem. However, the new challenges for the authority that appeared with the operation of Transantiago seem to have helped sensitising some political actors (e.g. the transport ministry) to the issue. Particularly difficult seems to be the change from an appointed regional authority to an elected regional government. Therefore, the creation of a regional transport authority with all the responsibilities defined in the proposal but still appointed by the president should be accepted as a temporary second best solution.

**Figure 7.7: Current Institutional Organisation of the Transport System in Santiago**



**Figure 7.8: Proposed Institutional Organisation for Santiago’s Transport System**



## 8. Fares' Structure in the Public Transport: European Experiences and Recommendations for Santiago

In this chapter we will analyse the fare structure in the public transport systems of the case study areas, because we are searching for recommendations for the improvement of the fare system in the public transport of Santiago.

This chapter starts with a description of the fare systems of the four metropolitan areas (Santiago, London, Berlin and Madrid), followed by a comparison and discussion of these fare systems. The main aspects that are analysed here are the integration level of the fare structures, the existence and convenience of travelcards, the relation between fares and trip length, the existence and convenience of reduced fares in specific periods or areas, the average level of the fares in the different metropolitan areas, the existence and convenience of subsidies and the financial equilibrium of the systems. Finally, a summary or recommendations for Santiago and conclusions are presented.

### 8.1 Fares in the Public Transport of Santiago

The public transport system of Santiago is undergoing a major change. This transformation will affect the fare system both in terms of the structure of the fares and the payment system.

**Until 2006**, the public transport system of Santiago had a non-integrated fare system, i.e. users had to pay a fare every time they boarded a bus, a shared-taxi, or when they entered the metro network. Only the metro had network-wide fares, implying that passengers could change without further payment between metro lines. In all other cases a transfer yielded a new full payment of the fare, making bus-metro trips and bus-bus trips very expensive.

In buses and metro the fare was independent of the travelled distance. Only the shared-taxis sometimes had distance-related fares, which could vary between approximately one and three times the normal bus fare.

In the case of the buses the full fare was circa € 0.45 in 2003. Metro had a differentiated fare of € 0.50 in the peak hours (weekdays 7:15 to 9:00 and 18:00 to 19:30) and € 0.40 in the off-peak periods, in order to give an incentive to those who can change their travel time to travel in off-peak times. This fare-differentiation policy was implemented as a way to delay the need to buy more trains to supply the highest demands of the peak hours. Both buses and metro had a reduced students' fare of € 0.15. Elderly could also pay this reduced fare in the metro between 9:00 and 18:00. From time to time Metro made special agreements with a few bus lines in order to provide a special integrated fare, lower than the addition of the metro and bus fares. But the reductions were always small and the scheme had little impact.

Neither bus operators nor the metro received operational subsidies. Therefore, operational costs had to be covered by the fare incomes and other minor earnings (e.g. publicity). Bus fares were determined in the tender of the services and revised every month through a

mathematical formula established in the contracts that changed the fare according to the impact that the prices of fuel and other inputs had on the costs of the bus operators. In the case of the metro, the fare was fixed by the government and normally changed once a year. Since 2000 the metro fares have been calculated with the aim of not only covering operational costs, but also paying a part of the investment of new metro infrastructure.

Regarding the paying method, in buses and shared-taxis the payment was directly made to the driver, whereas metro users had to buy in advance a single magnetic ticket or a rechargeable contactless electronic card (the latter was introduced in 2003).

**By the beginning of 2007** the *Transantiago* scheme, as discussed in chapter 2, should be completely implemented. This will contain a new route structure together with a new fare system. Just to remember, the bus routes will be divided into two complementary networks: main bus lines that allow long trips through different zones of the metropolitan area, and feeder (or local) lines that allow travelling inside specific areas and interchanging with the main bus lines and metro network.

The new fare structure will integrate both bus and metro fares, so that transfers can be made free or at a reduced transfer fare. The different fares<sup>9</sup> and the number of trips made paying each one of them, according to demand estimations (Transantiago, 2005b), are:

- 14 % of the trips will only use local or feeder services, paying a local fare of about € 0.4. Transfers between local lines inside an area are free.
- 75 % of the trips will be made using only main bus lines or the metro, at a fare of approximately € 0.45. Transfers between main bus lines, between metro lines, and between main bus lines and metro lines are also free.
- 10 % of the trips will use local lines and main bus lines or metro. In those cases, a transfer fare will have to be paid, yielding a total fare of about € 0.48.
- 1 % of the trips should use feeder lines at the start of the trip, then main bus lines or metro, and at the end a feeder line in another local area. Those trips will have to pay a transfer fare twice, and the total fare should be approximately € 0.52.

The fare remains independent of the trip-length, although there is a cheaper fare for local trips, which are normally shorter than the average. As before, a reduced students' fare at 35 % of the normal fare will exist. There will be a completely flat fare allowing up to three free transfers between buses and metro (in a 90 minutes period) during the first six months of operation.

The main paying method will be a contactless smartcard like the one introduced by Metro in 2003. This card has to be charged in advance and the corresponding fare is automatically deduced from it, as the paying system recognises if the user is starting a new trip or just making a transfer in the allowed transfer time. It will also be allowed to pay in cash in approximately 50 % of the buses, but at a higher fare and without the possibility of the integrated reduced fares when transferring.

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<sup>9</sup> The values of the fares are estimative figures. According to the authorities, the new fares will be on average similar to the old ones.

As before, no operational subsidy is considered for the system, i.e. fares have to cover the operational cost of buses and metro. The users of the public transport system pay about € 570 million in fares per year.

## 8.2 Fares in the Public Transport of the Selected European Metropolitan Areas

### 8.2.1 Greater London

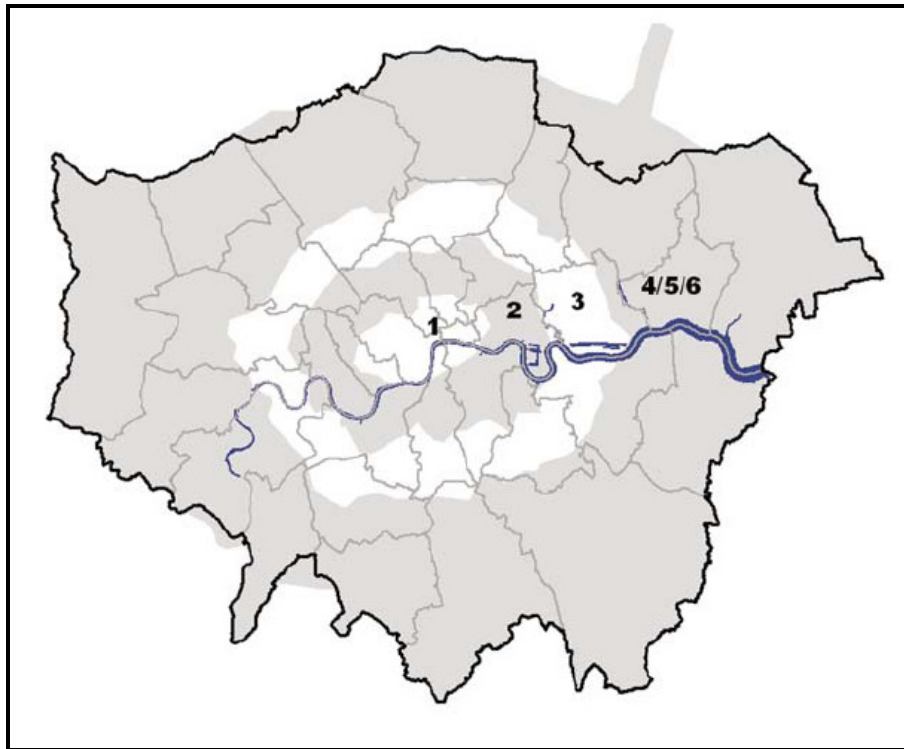
Greater London has a mix of mode-specific and intermodal fares. Single fares are mainly mode-specific, while travelcards are mostly intermodal. Buses and trams share a common fare and ticketing regime, and the Underground and the DLR another. The latter have a zone fare system charging higher prices for longer trips, while the former have a single flat fare all over Greater London. Superimposed on these mode-specific regimes is the travelcard system. It provides tickets with validities from one day to one year, which are accepted on the DLR, buses, railways, trams and the Underground. The Fares and Tickets Guide (TfL, 2006a) is published yearly by Transport for London with details on all available tickets.

In 2004, a new multi-modal contactless smartcard called **Oyster Card** was introduced in Greater London. It can be used in prepaid mode to pay individual fares or to carry various travelcards and other passes. It can be recharged and users need only to swipe it near the card reader, instead of feeding it into a ticket machine. Therefore, the passage through the ticketing gates is faster. In order to encourage the use of the Oyster Card, reduced fares are offered when paying with it, in comparison to the cash fares. A “capping” system was introduced in 2005, which guarantees that an Oyster Card user will be charged no more than the cheapest combinations of single tickets and travelcards that cover all journeys made that day. Over 3 million cards had been issued by January 2006 (TfL, 2006b).

**Buses and trams** had in 2006 a single flat fare all over Greater London of € 2.3 when paying in cash and € 1.5 (morning peak, i.e. weekdays between 7:00 and 9:30) or € 1.2 (off-peak) when paying with the Oyster Card. Passengers have to pay these fares each time they board a vehicle, i.e. no free transfers are allowed. A bus pass allowing unlimited travel in buses and trams all over Greater London for one day costs € 5.3 (cash). With the Oyster Card “capping” system the maximal daily-accumulated bus fare is € 4.5. Bus passes can also be bought (cash) for a week (€ 20.3), a month (€ 77.9) or a year (€ 810).

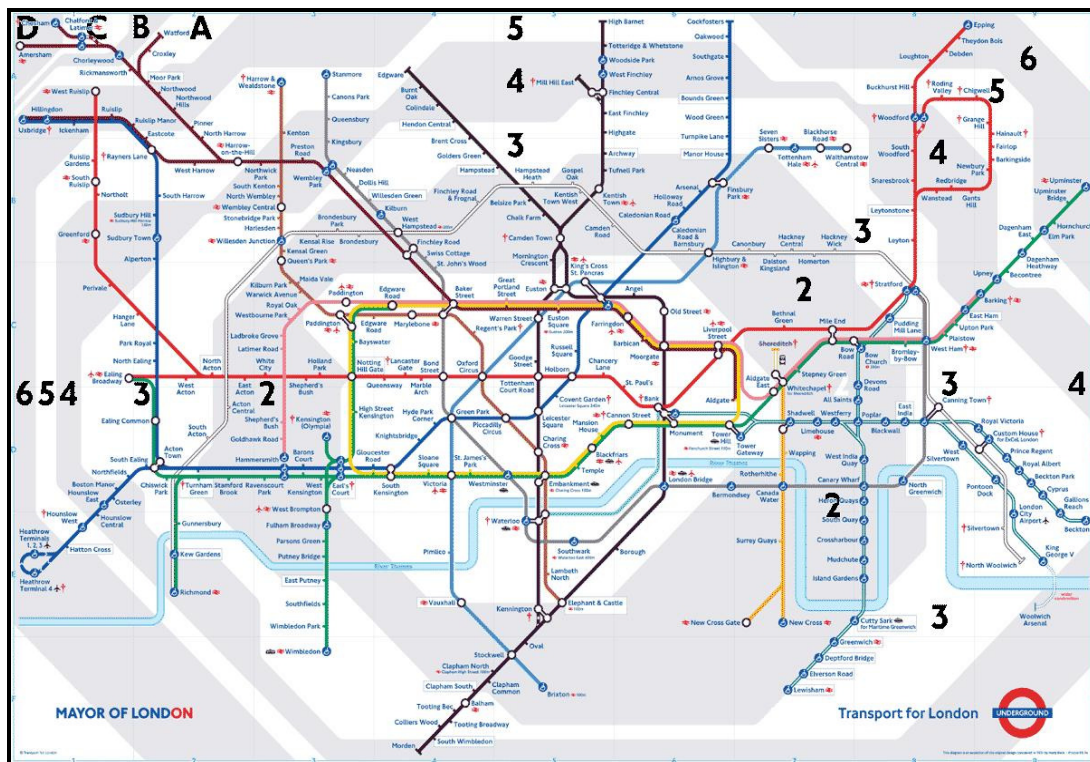
The fare system of the **Underground and Dockland Light Rail (DLR)** divides Greater London into six concentric zones (figure 8.1). Zone 1 is the most central zone and its boundary roughly corresponds to the route of the Underground's Circle Line, including all of Greater London's principal railway termini and most of the typical tourist attractions. Zone 2 is the next zone, still mainly inside inner London. Zone 6 is the last zone covering the external areas of Greater London. Figure 8.1 shows the fare zones over the boroughs of Greater London and figure 8.2 presents the tube map over the fare zones. Four additional zones are named as zones A to D, having only relevance for the eight stations of the Underground's *Metropolitan Line* that are outside Greater London.

Figure 8.1: Greater London Fare Zones and the Boroughs



Source: TfL (2005d p4)

Figure 8.2: Greater London Fare Zones and the Underground



Source: TfL

Single fares for the underground and DLR for zones 1 and 2 and for all zones in Greater London (1 to 6) are shown in table 8.1. Single fares allow transfers between different lines.

**Table 8.1: Example of Underground and DLR Single Fares in Greater London in 2006**

Zones	Cash (€)	Oyster Card peak periods <sup>(a)</sup> (€)	Oyster Card off-peak periods <sup>(b)</sup> (€)
Zones 1+2	4.5	3.0	2.3
All zones	6.0	5.3	3.0

<sup>(a)</sup> Peak periods: weekdays between 7:00 and 19:00 <sup>(b)</sup> Off-peak periods: all other times  
Source: TfL (2006a)

The same zones apply for travelling with **national rail services** inside Greater London. Single fares allowing travelling in rail services, the underground and DLR are priced depending on the number of zones crossed. In 2006, a trip through 1 zone had a price of € 4.5, through 2 zones € 5.1 and through all the 6 zones of Greater London € 9.3.

**Travelcards** (table 8.2) allowing unlimited underground, DLR, and national rail travel within the zones covered by the ticket are also available. All travelcards can also be used in buses all over Greater London, regardless of the validity zones of the ticket for the rail services. There are one-day, 3-days, 7-days, monthly and annual travelcards available.

**Table 8.2: Example of Travelcard Costs in Greater London in 2006**

Zones	One-day off-peak periods <sup>(a)</sup> (€)	One-day weekdays (€)	Monthly (€)	Annual (€)
Zones 1+2	7.4	9.3	128	1,332
All zones	9.5	18.6	236	2,460

<sup>(a)</sup> Off-peak periods: weekdays after 9:30 and weekends  
Source: TfL (2006a)

Travelcards for different combinations of zones can be found. Travelcards not including zone 1 are always cheaper. For example in the case of the one-day travelcard, the cheapest available combination is for zones 2 to 6 in the off-peak (weekdays after 9:30 and weekends) for € 6.5.

The travelcard was introduced in London in 1983, with the aim of providing an intermodal ticket (Konsult, 2007). First it covered the underground and buses, and later also the railway lines inside Greater London. The travelcard can be bought as a paper ticket or can be charged onto an Oyster Card.

There are **special reduced fares** for certain population groups. Children and young people under 16 have reduced fares in the Underground, DLR and rail services, and can travel free in buses and trams. Older and eligible disabled people who live in a London borough can also travel free. In these cases, the corresponding local borough council pays for the pass. In 2006, disabled people could travel free in the tube, buses, DLR and trams without time restriction, and in national rail services after the morning peak. Greater London citizens over 60 could travel free after the morning peak in the tube, buses, DLR, trams and national rail services in Greater London.

The public transport system of Greater London receives **subsidies** for its operation. Transport for London spent € 7,200 million in fiscal year 2003/2004. The revenue from

passenger fares, street management activities and other services was € 3,450 million. The UK government, the Greater London Authority and third parties, provided a total of € 4,200 million (EMTA, 2005b). Consequently, TfL covered 48 % of its costs with passenger fares and other revenues. Table 8.3 shows the main expenses of TfL.

**Table 8.3: Main Expenses of Transport for London in 2003/2004**

Mode	Expense (million €)	Expense (%)
Underground	3,900	57
Buses	1,950	28
Roads	956	14
Rail	42	1

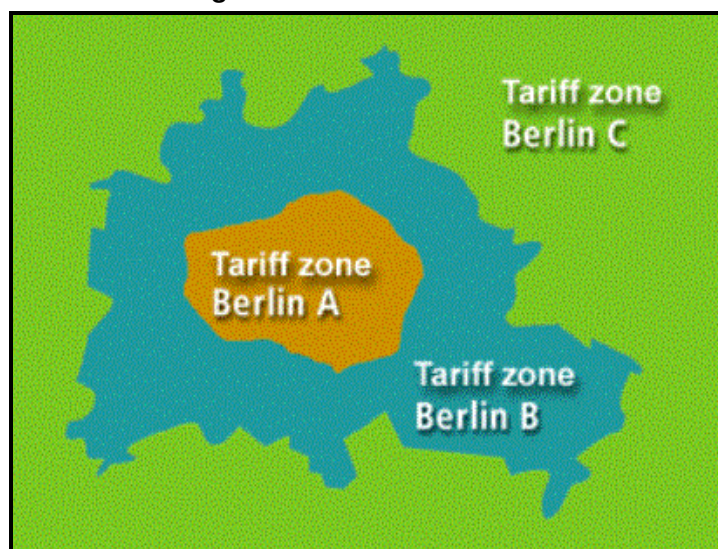
Source: EMTA (2005b p70)

TfL invested € 1,294 million in 2003/04: € 290 million on vehicles and equipment, € 1,000 million on infrastructure and € 4 million on land and buildings (EMTA 2005b).

### 8.2.2 Berlin

Berlin and Brandenburg are organised as a *Verkehrsverbund* (see chapter 7) hence they have a fully integrated and intermodal fare system, i.e. both single tickets and travelcards allow free transfer between all public transport modes: buses, trams, metro (*U-Bahn*) and urban rail (*S-Bahn*). Fares in Berlin are based on a zone system that considers 3 concentric areas (figure 8.3). Zone A is the city centre, zone B the rest of Berlin and zone C a ring in the periphery of Berlin. Tickets can be bought for the combination of zones A+B, B+C or A+B+C.

**Figure 8.3: Berlin Fare Zones**



Source: Morpha.de (2006)

Users can pay a single fare each time they travel, or pay for a travelcard that allows unlimited travel during a day/week/month/year. In all the cases the tickets are valid for all public transport modes and allow free transfers. Table 8.4 shows some of the fares that were available in Berlin in 2006.



Table 8.4: Example of Fares in Berlin in 2006

Zones	Single fare (€)	One-day pass (€)	Monthly pass (€)	Annual pass (€)
AB	2.1	5.8	67	650
ABC	2.6	6.0	83	805

Travelcards normally allow taking along a second adult and up to three children between 6 and 13 years for free after 20:00 on weekdays and all the day on weekends. Children up to 6 years can always be taken along for free. A bicycle can also be taken along with a travelcard, if there is enough space in the vehicle.

A **reduced monthly pass** allowing unlimited travel weekdays after 10:00 and all day weekends was available at a cost of € 49.5 and € 61.0 for zones AB and ABC respectively in 2006. There are other reduced monthly passes for students, employees of companies that subscribe an agreement with the transport authority and people that receive social security benefit.

On the other hand, there is a **reduced single fare** of € 1.2 for very short trips (*Kurzstrecke*). In addition, there are also reduced fares for children between 6 and 13 years.

A **change in the boarding procedure of the buses** was introduced in April 2004 in Berlin. Previously, all doors could be used to board and alight, and there was no need to show a ticket when boarding. The only ticket control was random inspections inside the vehicles. Now, all buses have only one allowed entrance (the first door), and the driver has to control the tickets. The aim of this measure is to decrease the level of payment evasion. According to the BVG (2004c p5), the test phase of this idea showed that passengers did not have big problems to accustom themselves to the new procedure. In addition, most of the times the buses needed less time at the stop, because passenger boarding and alighting did not meet at the same door. The introduction of the same boarding control procedure in several smaller German cities (Bochum, Gelsenkirchen, Remscheid, Bottrop, Recklinghausen, among others) was analysed by Ankum-Hoch (2004). According to that research, the new procedure helped reducing evasion by some 50 %. However, as drivers could not verify the validity of some tickets (e.g. electronic cards), especially some young users felt disposed to continue evading the payment. Negative aspects of the measure were that

- the punctuality of the services was threatened by longer stop times when higher occupancy factors of the buses and a high number of boarding passengers were observed,
- drivers mostly felt that their work became more difficult and
- passengers perceived a decline in the friendliness of the drivers.

There are **plans to introduce an electronic ticketing system** in Berlin through a contactless card (Tick-et-portal, 2004; Die Tageszeitung, 2005). In addition, an idea for a completely new fare structure was discussed in 2003 (BVG, 2004d; Berliner Zeitung, 2003; Berliner Morgenpost, 2003). According to this idea, fares would be proportional to the actual distance on an imaginary straight line between origin and destination. By doing so, the current zone system would be eliminated. A price differentiation between products is being

considered, making for example a trip in low-demand periods cheaper than the same trip in peak hours or differentiating the price depending on the transport mode. In addition, intensive users would receive higher discounts. A necessary previous condition for the introduction of the new fare structure is the implementation of the electronic ticketing system. By 2006, neither the new fare structure nor the electronic ticketing system was introduced yet.

Public transport operational **subsidy** reached its peak in 1993 (table 8.5). In addition to the subsidies for the BVG and S-Bahn, the DB Regio, which operates regional rail services, received € 44 million in 2004 (SfS, 2006a). The fare income of the BVG was approximately € 468 million in the same year. This income together with the operational subsidy were not enough to cover all BVG operating costs, yielding a deficit of € 106 million in 2004 (SfS, 2006b p7). BVG covered 47 % of its costs with fare revenues.

**Table 8.5: Yearly Subsidy for the Operation of the Public Transport in Berlin**

Year	BVG <sup>(a)</sup> (million €)	S-Bahn <sup>(b)</sup> (million €)
1990	521	N/i
1993	767	N/i
1996	485	221
1999	471	221
2002	420	221
2004	420	194

<sup>(a)</sup> Underground (U-Bahn), tram and bus. <sup>(b)</sup> Suburban rail.

Sources: SfS (2004p and 2006a)

In table 8.6 the investment in streets and rail modes in the last years is presented. The investment in rail modes has been higher than the investment in streets.

**Table 8.6: Yearly Investment in Streets and Rail Modes in Berlin**

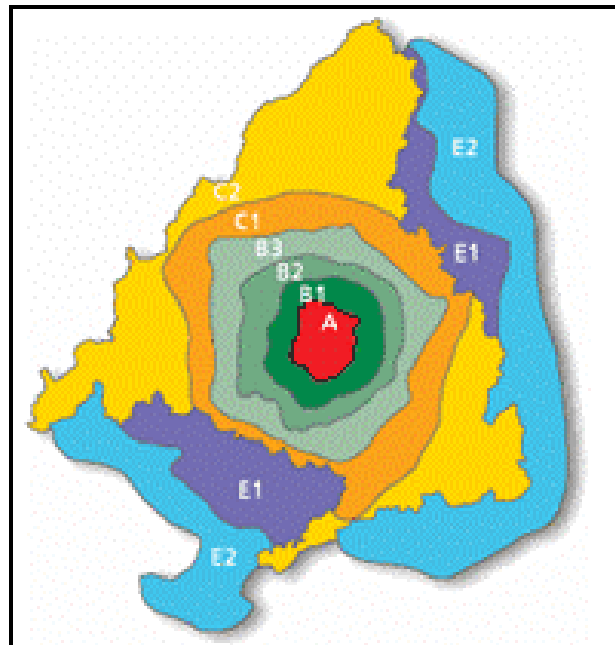
Year	Streets investment (million €)	Rail modes <sup>(a)</sup> investment (million €)
1991	128.1	231.6
1995	249.2	386.2
1999	129.7	261.4
2002	71.8	198.1

<sup>(a)</sup> Underground (U-Bahn), tram and suburban rail (S-Bahn)

Sources: SfS (2004n and 2004o)

### 8.2.3 Madrid

There were mainly two types of tickets in Madrid in 2006: single tickets, which could be bought as 10-ticket-package or as the more expensive one-trip-ticket, and travelcards, which allowed unlimited travel during a month or a year. Single tickets are mode-specific, while travelcards allow the use of all public transport modes within its valid travel zone and period. In both cases a zone-fare system applied, consisting of six zones in Madrid Region and two additional outlying zones (E1 and E2) in the adjacent Region of Castilla – La Mancha, as shown in figure 8.4. Madrid City practically coincides with the smallest zone A.

**Figure 8.4: Fare Zones in Madrid Region**

Source: CRTM (2004e)

In 2006, the **urban buses** in Madrid City (zone A) had a single flat fare of € 1.0. In addition, a 10 trip coupon could be bought at a price of € 6.15. In both cases the fare allows to travel only in one bus line, i.e. a new fare has to be paid in case of a transfer to a second bus line. Exactly the same fares apply for the **metro** system, but in this case the fares allow transferring between lines, so that a trip between every pair of metro stations can be made paying only one fare, at least inside zone A, where the majority of the metro network is.

Single fares for the **suburban rail** depended on the number of zones travelled (table 8.7). The **suburban bus** also had single fares that depended on the number of zones travelled. Each one of the more than 30 suburban bus companies had their own fares, in similar ranges to the suburban rail fares.

**Table 8.7: Example of Suburban Rail Fares in Madrid Region in 2006**

Zones	Single fare (€)	10-trip coupon (€)
1 or 2 zones	1.1	5.7
All zones	3.4	26.2

In addition to the single fares, a **travelcard** (*abono de transporte*) can be bought allowing unlimited travel within its valid travel zone and period in all public transport modes, i.e. metro, urban and suburban buses and suburban rail (table 8.8). The zones of the travelcard are the same as the zones for the single fares (shown in figure 8.4). In 2006, travelcards for those zones could be bought for a month or a year. In addition, a “tourists” travelcard for 1, 2, 3, 5 or 7 consecutive days was sold, but only for zones A (Madrid City) and E2 (all Madrid Region plus the additional outlying zones in the adjacent Region of Castilla – La Mancha). In spite of its commercial name, people who live in Madrid can also buy this travelcard. Finally, a monthly travelcard valid only in the suburban rail, but allowing just two trips per day, was also available for different zones. All travelcards are personal and non-transferable.

**Table 8.8: Example of Travelcard Costs in Madrid in 2006**

Zones	One-day pass (€)	Monthly pass (€)	Annual pass (€)
Madrid City (A)	3.5	39	429
Madrid Region (C2)	-	71	781
E2	7.0	94	-

**Reduced fares** for young and senior citizens are provided through special travelcards. The monthly young travelcard had a cost of approximately 65 % of the normal travelcard in 2006, and was available for all the zones. Highly reduced, the senior travelcard had a price of only € 9.9 (monthly card) and € 108.9 (yearly card) with spatial validity in Madrid Region (C2).

In 2000, more than 1 million people used travel passes every month. 60 % of the used travelcards were normal passes, while about 20 % corresponded to senior cards and another 20 % to young cards (Cristóbal-Pinto, 2002). From all the public transport trips made in 2002, 66 % were made using travelcards, 24 % using multiple trips coupon and 10 % using the single trip ticket (EMTA, 2004b p35). Since its creation in 1987, the use of the travelcard has been rising, reaching 33 % of the trips in 1989, 40 % in 1990, 52 % in 1992 and more than 60 % in 1996 (CRTM, 2004f p48).

CRTM (the public transport authority of Madrid) centralises the major part of the fare incomes. Only single tickets revenues are directly managed by *Metro de Madrid* and EMT (urban buses company), and the revenue of both single tickets and multiple trips coupons are directly managed by the suburban modes EMTA (2004a p67).

The public transport system of Madrid receives **operational subsidies**. In 2003, the yearly operation cost of the public transport system in Madrid Region was € 1,255 million (table 8.9). The yearly revenue from overall ticket sales was € 623 million, covering 50 % of the operational costs. CRTM negotiates at several political levels and comes to agreements with various administrative bodies to obtain the subsidies that supplement fare revenues in financing the system (table 8.10).

**Table 8.9: Main Public Transport Expenses in Madrid Region in 2003**

Mode	Expense (million €)	Expense (%)
Metro	580	46
Urban buses	288	23
Interurban buses and trains	310	25
CRTM	34	3
Other	43	3

Sources: CRTM (2005 p7) and EMTA (2005b p73)

Approximately € 400 million were yearly invested in the extension of the metro network between 1995 and 2003 in Madrid (Cristóbal-Pinto, 2002). Infrastructure investment in the metro network is supported by the Regional Government, whereas suburban rail investments are managed by the National Government. Funds for rolling stock renewal come directly from the public transport operators in the case of rail modes (EMTA, 2004a p67).

**Table 8.10: Operational Subsidy in Madrid Region in 2003**

Mode	Subsidy (million €)	Subsidy (%)
National government	143	21
Regional government	414	62
Madrid municipality	110	17

Sources: CRTM (2005 p7) and EMTA (2005b p73)

## 8.3 Comparison, Discussion and Recommendations for Santiago

### 8.3.1 Fare integration

After the revision of the fare systems of the four analysed capital cities, different types of fares were recognised, in terms of its integration level. The following definitions will help us to classify the fare structures of the different metropolitan areas<sup>10</sup>:

- **Type A, no fare integration:** a new fare has to be paid each time the passenger boards a vehicle.
- **Type B, mode-specific fare integration:** free (or reduced) transfer inside one public transport mode.
- **Type C, intermodal fare integration:** free (or reduced) transfer inside and between different public transport modes.
- **Type D, travelcard:** free transfer and unlimited number of trips inside a validity period.

The following figures show the fare integration that exists in each capital city and each public transport mode, in the case of single fares (figure 8.5) and travelcards (figure 8.6).

**Figure 8.5: Fare Integration in the Metropolitan Areas (Single Fares)**

	Trams	Buses	Metro	Rail
<b>Santiago</b> before TS <sup>(a)</sup>	-	A	B	A/B <sup>(b)</sup>
<b>Santiago</b> after TS <sup>(a)</sup>	-	C		A/B <sup>(b)</sup>
<b>London</b>	A	A	B <sup>(c)</sup>	
<b>Berlin</b>	C			
<b>Madrid</b>	-	A	B	B

<sup>(a)</sup> TS: *Transantiago*. <sup>(b)</sup> There is only one urban rail line in Santiago.

<sup>(c)</sup> Metro and DLR have a common fare system in London.

<sup>10</sup> For a detailed list of types of fares found in different cities see Balcombe et al. (2004 p50) or White (1995 pp125-127).

**Figure 8.6: Fare Integration in the Metropolitan Areas (Travelcards)**

	Trams	Buses	Metro	Rail
Santiago	-			
London	Travelcard (D)			
	Travelcard (D)			
Berlin	Travelcard (D)			
Madrid	Travelcard (D)			

The **integration level of the single fares** is low in all metropolitan areas except Berlin, where fully integrated single fares exist. London, Madrid and Santiago (before *Transantiago*) have a similar single fare system, in which bus (and tram) fares have to be paid each time a vehicle is boarded, while metro and rail single fares allow free transfers inside their respective networks. Greater London presents an exception to this rule, providing a special integrated single fare for metro and rail that allow free transfers between both networks. Berlin, as described above, has a fully integrated single fare, allowing free transfers between all public transport modes. Interestingly, after the implementation of *Transantiago*, Santiago will have a more integrated single fare scheme than London and Madrid, allowing free or reduced transfers between buses and metro.

Regarding the **travelpasses**, the three European capital cities have fully integrated travelcards that allow unlimited travel in all public transport modes of the metropolitan area. This is a very interesting finding in terms of recommendations for Santiago, as even under the new *Transantiago* system no travelcard or similar pass is considered for implementation. Therefore, advantages of a travelcard and the eventual convenience of the introduction of such a pass in Santiago are further analysed below.

### 8.3.2 Travelcards exist in the European metropolitan areas... and in Santiago?

Before discussing the convenience of implementing a travelcard in Santiago, let us give a precise **definition** of the term "travelcard". White (1981 p17) defines it as a ticket that allows unlimited travel within a given period and within a network (or a substantial part of a network). Thus a card that gives discounts in the normal fare is not included in the concept of a travelcard, and a ticket allowing unlimited travel only in a specific route does also not fit into the travelcard concept. The concept of a travelcard is completely independent of the technology used for its implementation. It can be a simple piece of paper or a very sophisticated electronic device.

The **first travelcards** were introduced in the 1950s both in West Germany and the United Kingdom (Edinburgh). However, the really rapid expansion dates from the Stockholm card introduced in 1971 (White, 1981 p19). Different **commercial names** have been given to this type of tickets, e.g. "Ridecard", "Bus Pass" and also more imaginative names like "Environmental Protection Card", "Ticket 2000", "Bears Ticket" and even "Chocolate Ticket". Though, probably the best-known name in English is "Travelcard". The name was given to one of the first of these tickets in Edinburgh in 1957.

Travelcards are commonly available in European metropolitan areas, and a high proportion of the public transport passengers often use them. For example, 92 % of all public transport trips in Vienna are made using a travelcard, while there are figures of 82 % in Stockholm, 78 % in Hamburg, over 60 % in Madrid, 54 % in Zurich and 50 % in Munich (Matas, 2004 pp198-199).

Travelcards can be personalised or transferable. If the travelcard is personalised and is lost or stolen, the user gets a new travelcard for free and the old one loses its validity. A transferable travelcard (not personalised) can be used by different people (at different times). In many metropolitan areas the user can choose between a personalised and a transferable travelcard (e.g. London, Freiburg, Zurich, Rhein-Ruhr Region, Frankfurt-Rhein-Main Region). However there are cases in which only personalised travelcards are offered (Madrid, Hamburg) and also cases where only transferable travelcards can be bought (Berlin, Vienna, Stockholm).

### **Impact of travelcards on public transport demand**

Interestingly, there is evidence in the literature about a positive impact of the introduction of travelcards in the public transport demand. For example, Matas (2004 p207) estimates a patronage increase in Madrid City between 1986 and 2001 of 7 % in the buses and 15 % in the metro attributable to the introduction of the travelcard (the rest of the total increase of 24 % in the buses and 65 % in the metro is due to other factors like network expansions or GDP increase). Moreover, FitzRoy and Smith (1998) estimate that the introduction of travelcards in the German city of Freiburg yielded a 7 % to 22 % increase in the public transport trips per capita. In another study, FitzRoy and Smith (1999) report the following impact of the introduction of travelcards in the public transport patronage in four Swiss metropolitan areas: Geneva 16 %, Bern 14 %, Basle 5.4 % and Zurich 4.5 %. An estimation for London suggests an even larger impact of the introduction of a travelcard and fare revision in May 1983, which should have increased underground passenger-miles by 33 % and bus passenger-miles by 20 % from 1983 to 1991 (London Transport, 1993). In addition, two studies found that the introduction of travelcards in London stimulated public transport demand (Gilbert and Jalilian, 1991; Fowkes and Nash, 1991; both in Balcombe et al., 2004 p62). Comparing the relative success of light rail systems in different metropolitan areas in Europe, North America and Australia, Hass-Klau and Crampton (2002) also found that the existence of a travelcard is a key issue in the systems with the highest patronage figures (see Appendix A).

But how can a simple ticket increase the patronage of the public transport? It could be argued that the introduction of travelcards may reduce the average fare, and therefore increase the patronage not because of the ticket, but due to the overall price reduction. Nevertheless, the studies cited in the previous paragraph separate the effects of an eventual change of the average fare and the introduction of the travelcard, so that the impacts on the demand mentioned are only those attributable to the appearance of the new ticket: the travelcard. So which are the real benefits of travelcards for the users that could explain an increase in patronage? White (1981 p18) and Matas (2004 p198) suggest the following advantages:

1. The need to worry about the fare required (especially for “exact fare” systems) is virtually removed.
2. Interchange penalties are reduced because there is no need to pay a new fare (or a transfer fare).
3. Boarding and queuing time can be reduced due to an “easier” payment system.
4. Once the pass is purchased, it permits travel at zero marginal cost. Thus extra trips, such as returning home to lunch from work, weekend leisure trips, etc., are “free”.

A detailed enumeration of the benefits of travelcards not only for users, but also to operators, local authorities and employees is presented in White (1981). Some of them are relevant for the analysis of an eventual implementation of a travelcard in Santiago, and will be discussed later in this chapter.

Probably the most important explanation for the patronage increases is the fact that after purchasing the travelcard, additional trips can be made for free<sup>11</sup>. These can imply the generation of new trips (e.g. returning home to lunch) or a change in the origin, destination or mode of an “existing” trip. From a social viewpoint, the ability of a travelcard to divert car trips to the public transport is especially interesting. Some authors state that the impacts of a travelcard include “a high probability of attracting new users” (Matas, 2004 p 198), i.e. passengers that previously did not use public transport. FitzRoy and Smith (1998 p169) report that 3,000 to 4,000 regular car drivers had switched to public transport one year after the introduction of the travelcard in Freiburg, Germany. However this switch is probably explained by other additional factors. Hass-Klau and Crampton (2002 pp38-39) argue that in addition to the travelcard and a superb public transport system, a wide range of sustainable transport policies explain the success in Freiburg: long pedestrian streets, traffic-calmed streets outside the historic centre, a large cycle network, one of the best examples of coordinated land-use and transport planning in Europe. Between 1982 and 1998 the car modal split in Freiburg stayed constant despite a 12 % increase in car ownership and it is assumed that daily 30,000 car trips have been replaced by public transport (Hass-Klau and Crampton, 2002 p39).

### **Critics to travelcards**

The main critic to travelcards found in the literature is that they can have a negative impact on the financial equilibrium of the system. This negative financial impact has two causes:

- First, that frequent users buying the travelcard will do so because this is cheaper for them than continue paying the cash fares, implying a reduction in the fares revenue of the operator (Doxsey, 1984).
- And second, that the extra demand generated may cause additional operating costs, if the new patronage occurs where the public transport did not have spare capacity.

Regarding the **first problem**, Doxsey (1984) builds a model that predicts losses in revenue as a consequence of introducing travelcards. Nevertheless, as stated by FitzRoy and Smith (1998 p169), his model overlooks the passenger generation effect of travelcards, because it only considers the choice faced by existing public transport users between purchasing a

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<sup>11</sup> This is a very important difference with a multiple-trip coupon. With the latter, the passenger pays in advance a more convenient fare for a **fixed number of trips**. In the case of a travelcard, the user pays in advance for an **unlimited number of trips over a fixed time period**.



travelcard and paying cash fares. Matas (2004 p207) states that the revision of the related literature leads to the conclusion that the implementation of travelcards does not necessarily reduce fares revenue.

An important aspect that has to be taken into account here is the difference between the price-elasticity of the single tickets and the travelcards (see Appendix A). The evidence found in the literature (for instance, reviews by White, 1981 and Matas, 2004 pp210-211) shows that travelcards have a lower (in absolute value) price-elasticity than single fares, i.e. that the decrease in travelcards sales produced by a growth in their price is lower than the sales decrease in single fares generated by an increase in the single fares. Some authors even report price-elasticities close to zero for the travelcard. Therefore, White recommends the following strategy to reach a high market penetration with the travelcards and avoid a long term decrease in the fare revenues: to start introducing the travelcards at low initial prices together with higher single fares and then, given the low price-elasticity of the travelcard, to rise its price (and eventually also the single fares). This may yield a high proportion of trips being made with travelcards without a drop in total fare revenues. Several reports of cases where the introduction of travelcards did not affect fare revenues can be found in the literature: Freiburg (FitzRoy and Smith, 1998; Hass-Klau and Crampton, 2002), London (London Transport, 1993), Edinburgh and West Midlands (White, 1981), as well as others where it actually reduced them: Madrid (Matas, 2004), some German speaking metropolitan areas analysed by Pucher and Kurth (1996).

In relation to the **second problem** (the eventual increase in operating costs due to the higher demand), it has to be emphasised that public transport usually has spare capacity at least in off-peak periods, implying that extra passengers can be carried in the already provided supply at almost no extra costs for the operators. In addition, a frequency increase in the off-peak period can be made at much lower cost than in the peak period due to the unused vehicles available in the off-peak, as discussed later in this chapter. However, if the additional patronage occurs where the system does not have excess capacity (peak hours, peak direction and section of the route with the highest load), an expansion of the service (e.g. higher frequency) may be necessary yielding important cost increases because new vehicles and drivers would be necessary.

Travelcards function like club entrance fees that allow free use of services for members (Sherman, 1967). A similar pricing strategy can be found in other industries, for instance the newspapers, which offer subscriptions at lower prices than the total price that the purchaser would pay if buying the newspaper every day. But given the very low marginal cost of the production of one exemplar, the newspapers prefer "loyal" clients with subscriptions. The key aspect here is the low marginal cost of producing an extra exemplar of the newspaper.

Finally, there is also **theoretical support** about the convenience of travelcards, both for users and operators. Carbajo (1988 pp154-156) shows in a simple microeconomic diagrammatic example that the introduction of a travelcard at an appropriate price can make all users and the firm better off than under a uniform single-price regime. In his example, after introducing the travelcard, users increase their number of trips and the operator increases its profit in spite of facing higher costs. He also argues that these overall benefits of an appropriately designed non-uniform price are a well-known finding in the non-uniform pricing literature, citing Brown and Sibley (1986).

### **About reduced fares for frequent users**

Some of the **users' benefits of travelcards** listed above will be reached, at least partially, with the new pricing system of *Transantiago*. In fact,

- passengers will not need to worry about the exact fare required (the correct amount will be deduced automatically from the smartcard), although different fares will exist, which will make passengers still interested in knowing the exact fare they have to pay;
- interchange penalties will be reduced, as some transfers will be free and others will have low transfer-fares;
- reductions in boarding times should be achieved because payment with the smartcard is notably faster than cash payment.

However, the “zero marginal cost” for extra trips is not provided in the new fare system of *Transantiago*. These free extra trips can be seen as a “reward” for frequent users, as is common in other industries. As discussed above, these extra trips do not have a relevant financial impact for the operators, as long as they are done using spare capacity (e.g. in off-peaks). Therefore, a possible improvement of the fare system of *Transantiago* would be the introduction of reduced fares for frequent users, as was suggested in Berlin in the context of a new fare scheme (BVG, 2004d). This could be done thanks to the technology of the smartcard that will be used in *Transantiago* which is able to register and count the number of trips made by the user. For example, a reduced fare could apply after reaching a certain amount of trips in one month. This would imply a non-uniform pricing scheme that, as stated by Carbajo (1988), can be positive both for users and operators if prices are adequately defined. This scheme could be used to promote off-peak trips if the reduced fare only applies in off-peak periods and weekends.

However, this scheme would imply some difficulties for the users:

- The fare structure would become more complicated. It has to be considered that the fare structure of the public transport in Santiago has been always very simple: a single flat fare for all buses and another flat fare for the metro, with only few exceptions to this simple rule.
- The passenger would not exactly know how much the next trip would cost because the fare would depend on his accumulated number of trips. It can be argued that the card reader will provide the relevant information about the cost of following trips each time the passenger pays. But this is still a difficulty for the user because he has to remember this information. Even if the information was printed and given in a ticket, the user would still need to make some effort in order to store only the last receipt and discard the old ones. In addition, the card readers used in Santiago are not designed to give printed receipts, and the implementation of a printer-module in more than 5.000 buses and more than 80 metro stations would imply a relevant cost.

A careful analysis of the impact of this proposition on demand, loadings and financial equilibrium should be made if there is future interest in their implementation<sup>12</sup>. However, the

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<sup>12</sup> The modelling tools available in Santiago (e.g. the ESTRAUS four stages equilibrium model) would provide the

author thinks that the expected benefits of this proposal are rather limited because it does not make a relevant change in the costs perceptions of the users. The introduction of travelcards seems to be much more interesting and will therefore be further analysed in what follows.

### **A travelcard for Santiago**

There is an important “social benefit” of travelcards that is not achieved by the *Transantiago* fare system and would not be achieved with the reduced fares for frequent users explained above. White (1981 p18) states that travelcards...

“...changed relative perceptions of costs. Cost perception for public transport is placed on a similar footing to that of a private car, and is made less direct, as the cost is incurred on a periodic basis rather than each time a trip is made. This may help to retain public transport patronage, and in some cases may assist diversion from cars to public transport. The practice may be extended by accepting renewal of travelcards by banker's order, and thus making renewal virtually automatic.”

This change in perception of costs does not occur when paying with a prepaid card, as the passenger still perceives the cost of each trip he makes. It could be argued that the perception of costs changes as the user has to charge the card in advance (probably doing so for several trips), and therefore does not pay (cash) at every trip. But this effect is lower than in the case of travelcards, when the payment is independent of the number of trips.

Although recognising that *Transantiago* will strongly improve the pricing system of the public transport in Santiago (because of the fares' integration), given the interesting characteristics of the travelcards analysed above, the implementation of a travelcard in Santiago is recommended here in order to improve its public transport fare system.

### **Critical analysis of the introduction of travelcards in Santiago**

Contrary to the previous proposal of a reduced fare for frequent users', travelcards do not present the difficulties discussed above. It does not imply a relevant complication in the fare structure because the old fare structure can be fully maintained. The travelcard is simply added as a new fare-product. As both single fares and the travelcard have a fixed price, there is no difficulty in knowing its prices in advance.

But there are other problems that would complicate the implementation of a travelcard in Santiago. Although very common in Europe, travelcards are completely unknown in Chile and, as far as the author knows, in Latin-America. This would imply a problem for the users, who would face a new type of public transport ticket. But a travelcard is a very simple ticket, and therefore it should be easy for the users' to learn how to use it. Nevertheless, the fact that travelcards are unknown would produce a previous difficulty because the concept of a travelcard is also unknown for most of the decision-makers in Santiago. At the decision-maker level, the problems that can be expected are:

- Travelcards are easily confused with multiple-trip coupons because of the name that is sometimes used in Spanish for travelcard: *tarjeta multiviaje* (literally translated into English: multiple-trip card).
- At first view, there seems to be an obvious financial impact of travelcards: frequent users will buy the travelcard and pay less than previously, whereas less-frequent users will continue paying single fares. If this were true, the travelcard would necessarily have a negative effect on fare revenues. However, as discussed above, it is possible to find travelcard and single fare prices to make all users and operators better off than under a uniform single-price regime.
- Finally, a new change in the fare structure could be politically interpreted as the recognition of a “failure” of the previous change (the introduction of *Transantiago* scheduled to occur by the beginning of 2007). However, it seems to be wise to wait some years after the introduction of this first pricing change before the implementation of a new change in the fare structure. This would allow the people to accustom themselves to the new fare system before changing it again, and in addition it would facilitate the acceptance of the decision-makers.

Because of the reasons described above (especially the first and second ones), it would not be easy to convince the decision-makers of implementing a travelcard in Santiago. Nevertheless, the author thinks that the expected benefits of a travelcard are worth the effort. On the other hand, the fact that the decision-makers supported the implementation of *Transantiago* (a much more difficult and risky project) shows that the opportunity for important but difficult improvements in the public transport of Santiago (sometimes) exists.

There is also a practical difficulty for the implementation of travelcards, namely that both the fare structure and the way in which the fare levels are determined are defined in the contracts between the transport ministry and the operators. As explained in chapter 2, this means that neither the authority nor the operators can change the fares at will. This procedure has been used since the first bus-operation tenders in Santiago in the early 1990s. Previous to *Transantiago*, it would have been practically impossible for the authority to negotiate a change in the fare structure with the thousands of bus operators. However, the implementation of *Transantiago* reduced the number of operators to only 10 companies, making it possible to seriously discuss and agree such a change with them. Actually, a simplification of the fare structure for the first six months of operation of *Transantiago* (completely flat fare allowing up to three free transfers) was successfully agreed between the transport ministry and the operators. Given that the bus-operation concessions were given for different periods (between 2 and 19 years) it is not possible to wait until the end of all concessions to introduce changes in the future contracts in order to include a travelcard in the fare structure. Therefore, it is necessary to agree the introduction of a travelcard with the operators. However, if the travelcard has not been introduced yet at the time of the next tenders, we recommend including in those new contracts the possibility of having a travelcard in the future.

The following characteristics of travelcards are important for the responsible authorities and the operators, and could be used as arguments to convince them of its benefits:

- Every person owning a travelcard is not able to travel without paying anymore! Evasion is a common problem in public transport and Santiago is not an exception.

The experience elsewhere has shown that the massive use of travelcards is a good way to reduce evasion. Travelcards at special attractive conditions can be provided for specific groups where higher evasion levels are found (e.g. young people who are by nature more willing to accept risks).

- Frequent users would benefit from a lower total fare and the possibility of making additional trips at zero cost if they buy the travelcard. Interestingly, most of the frequent users of the public transport system in Santiago belong to low-income families. This aspect should be of interest for the political authority as it represents a positive social policy.

All difficulties discussed above, which are mainly political, seem to be soluble. But the introduction of travelcards needs also to be technically possible, for this idea to succeed.

An electronic smartcard was massively introduced in Santiago with the implementation of *Transantiago*. Although it is currently only used as a prepaid card to pay single fares, a travelcard could be charged into this smartcard, as is done in London with the Oyster Card. Both travelcards use the same standard (Mifare), which is one of the more common standards for electronic smartcards. Therefore, no technological change seems to be needed in Santiago's smartcard in order to use it also as a travelcard.

Associated with the electronic smartcard, a selling and charging network was implemented, with more than 1,000 points where it can be charged throughout Santiago. This network could obviously also be used to sell and charge travelcards into the smartcard.

There are several public transport operators in Santiago and the revenue generated by travelcard sales would have to be divided and distributed among them. *Transantiago* introduced an integrated fare scheme, implying that there are rules defined in the contracts about the distribution of fare revenues among the operators. As explained in chapter 2, prices for several fare products are determined with the aim of covering overall costs (see equations 1 and 2). The travelcards revenue would simply have to be added to the overall incomes of the system in equation (1). For instance, if there is only one travelcard product, the total income of the system ( $I$ ) in equation (1) could be written as

$$I = \sum_i d_i \cdot f_i + d_{TC} \cdot f_{TC} \quad , \quad (3)$$

where  $d_{TC}$  and  $f_{TC}$  are the demand and price of the travelcard, respectively, and  $d_i$  and  $f_i$  the demand and price of the rest of the fare products. Thus, the travelcard is just one additional fare product and is handled as every other fare products without producing any new complication.

As seen, there seem to be no important technical problems for a successful implementation of a travelcard in Santiago. On the contrary, the integrated fare system, electronic smartcard and charging network introduced by *Transantiago* make the implementation of a travelcard particularly easy.

No one of the three conditions described above existed before the implementation of *Transantiago*. In fact, fares were paid in cash, no network existed for public transport ticket

sales (with the exception of the metro stations) and no revenue-distribution scheme among operators existed. There were thousands of bus operators and every bus produced its own revenue through the fares directly paid by the passengers to the driver. As there was no integrated fare and thousands of operators, the implementation of travelcards would have been absolutely impossible with the previous public transport organisation.

Finally, travelcards would produce the following impacts from the users' viewpoint:

- A change in the fare structure will always imply a new complication, at least initially. Something new has to be understood and learnt. However, if the old fare system is maintained unaltered (what is perfectly possible when introducing a travelcard), the impact of the new fare product will be softened as people will not be forced to change immediately to it. They can simply ignore the travelcard at the beginning and continue paying as before.
- Frequent users would benefit from a lower total fare and the possibility of making additional trips at zero cost as explained before.
- There is a group of "less intensive" users for which the cost of the travelcard is more or less the same as the accumulated cost of their trips if paying single fares. For them it is indifferent if they buy the travelcard or continue paying single fares, in terms of their expenditure. Nevertheless, if they buy the travelcard they would benefit of the possibility of making additional trips at zero cost.
- Infrequent users could be worse off if single fares are increased after the introduction of travelcards. This could be an important negative aspect. If single fares remain unaltered, then the introduction of travelcards would not affect them.

### **Price and implementation strategy**

Prices of travelcards and single fares are commonly determined using a simple relation between them (e.g. the price of a monthly travelcard may be 35 times the price of the single fare). Interestingly, Carbajo (1988) developed a microeconomic framework to jointly determine optimal prices for a travelcard and a single fare. Considering only one period (i.e. ignoring differences between peak and off-peak), he obtains mathematical solutions for the optimal prices under different policy objectives as maximum profit or the maximisation of social benefit subject to a financial constraint. The use of such kind of models to estimate optimal fares should be used if travelcards are introduced in Santiago.

White (1981 pp17-18) argued that the massive use of travelcards produce several benefits, for example:

- Reduction in stopping times because of quicker boarding (implying both lower travel times and lower operating costs).
- Simplification of cash handling and control through payment in advance.
- Improvement in cash flow because revenue received in advance is equivalent to a saving of interest on short-term borrowing.
- The possibility of network rationalisation as a result of reducing passenger interchange penalties.

However, in the case of Santiago all these benefits will already be (partially) achieved through the massive use of an electronic smartcard after the implementation of

*Transantiago*<sup>13</sup>. Therefore, the achievement of a very high market penetration with the travelcard would not be an imperative task, as it has been in other metropolitan areas before.

Nevertheless, the introductory strategy suggested by White (1981) to achieve high market penetration could still be used in Santiago to promote the use of the travelcard and accelerate its introduction: The price of the travelcard should be initially low, and then it should be increased until the long-term price defined for it is reached. Given the low (in absolute terms) price-elasticity of the travelcard (see Appendix A) this strategy should produce a higher travelcard use than if the long-term price was charged from the beginning.

Another typical measure to promote the use of travelcards is to increase the value of single fares. However, an increase of the single fares because of the introduction of travelcards would be politically difficult to accept in Santiago, as it would be perceived as a direct fare increase. In addition, it is easy to predict that higher single fares would reduce public transport use by infrequent travellers (although the complete scheme could still produce demand increases).

Is it possible to have a cheap single fare for travellers who use the public transport system infrequently but giving frequent users a pecuniary incentive (higher single fare) to buy the travelcard?

If an electronic smartcard is massively used, it is possible to define a differentiated single fare whose value depends on the number of trips made before. For example, let us assume that there was a flat single fare at a price  $P$  before the travelcard was introduced. After the implementation of the travelcard, the single fare could have the following price structure:

- $P$  if the passenger made up to 20 trips in the last 30 days
- $1.2P$  if the passenger made between 21 and 40 trips in the last 30 days
- $1.4P$  if the passenger made more than 40 trips in the last 30 days

With this single-fare structure, an infrequent user would not perceive an increase of its travel costs, whereas a frequent user would have to pay a higher single fare and therefore would have a pecuniary incentive to change to the travelcard.

The capacity of smartcards to record the information of previous trips over a long period of time (months) is a key condition for this differentiated single fare scheme. It is absolutely impossible to implement a differentiated single fare if it is paid in cash. As explained before, a new smartcard will be massively used in Santiago, providing the fundamental condition for a differentiated single fare as described here.

There is one problem that could be serious enough to make this differentiated single-fare strategy fail, and needs therefore to be carefully analysed before implementing it. If a passenger acquires several smartcards, he may pay always the cheaper single fare, even if he makes a lot of trips. Following the previous example, a person who wants to make 60 trips per month could acquire 3 smartcards and pay 20 trips with each card. By doing so, he

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<sup>13</sup> Users without a smartcard will only be able to pay in cash in some buses, but at a higher fare and without the possibility of the integrated reduced fares when transferring.

would always face the cheapest single fare  $P$ . Although the electronic smartcard will not be given free of charge, its cost has to be paid only once and therefore does not completely avoid this problem.

In addition, the implementation of this scheme would have some other difficulties that, being not as potentially serious as the previous problem, should be taken into account. The same difficulties as the above proposed reduced fares for frequent users would appear, as both ideas take advantage of the capacity of smartcards to store trips history and change the prices according to this record: fare structure would become more complicated and passengers would sometimes be uncertain about the price of the next trip. Another difficulty would arise before its implementation: Decision-makers may be sceptic about a fare product that increases its value when it is frequently used, as this sounds counterintuitive. Nevertheless, the author recommends considering the differentiated single-fare idea in the design of an eventual travelcard scheme for Santiago. It has to be emphasised that the differentiated single fare is not imperative for the introduction of a travelcard in Santiago.

### **Expected impact on demand and additional comments**

As several (but not all) of the benefits of travelcards will already be partially achieved in Santiago due to the use of an electronic smartcard, the impact on public transport demand of the introduction of a travelcard is expected to be lower in Santiago than elsewhere. The reported patronage increases due to the implementation of a travelcard ranged between 4.5 % and more than 20 %, as reviewed above in this section. In the case of Santiago the eventual patronage increase should be expected in the lower end of this range.

Finally, there are interesting special “offers” that usually accompany travelcards. They can be really very imaginative and original, but some of them have already become typical. The eventual inclusion of some of these extras should be analysed before introducing a travelcard in Santiago. Sometimes travelcards with and without the extras are offered (at different prices) simultaneously. The following is a list of travelcards “extras” found in different cases:

1. A second person and/or children can travel for free on the weekends and on weekdays after, let's say, 20:00 using the same travelcard.
2. The spatial coverage of the travelcard is extended in some off-peak periods.
3. A bicycle can be taken along for free.
4. Paying a supplement you can use better services (e.g. first class in local trains) or extend the spatial coverage of the travelcard.
5. Mobility guarantee: if your bus or train is delayed more than, for instance, 30 minutes, you can take a taxi and let the travelcard provider pay for the taxi (with some price limit).
6. If your clothes get dirty because the vehicle was not clean enough, you can let the travelcard provider pay you the laundry bill back (BVG – Berlin).

Interesting is also the case of travelcards for university-students in Germany (*Semesterticket*). The public transport authorities and operators negotiate with the universities the provision of a special travelcard for the students, which is valid for the whole term and has to be paid by all the students as part of their fees. If the university accepts the



travelcard (which is the typical case), no student can reject paying for the travelcard, even if he/she does not want to use the public transport system (e.g. because he/she owns a car). So a strong incentive for the use of public transport is given to the students. Moreover, as the ticket is also bought by some students who are not going to use the public transport frequently, it can be offered at a very attractive price. For instance, in the Rhein-Ruhr-Region the travelcard for students costs approximately a third of a normal city-travelcard, and allows travelling in a much wider area (the whole Rhein-Ruhr-Region).

### 8.3.3 Relation between fare and trip length

None of the analysed fares structures shows a direct relationship between the travelled distance and the fare. Nevertheless, some of them seem to have an implicit relationship through fares zone systems in which trips passing through more zones are more expensive than trips using fewer zones. As explained before, Berlin is planning a new fares' system in which the prices would be exactly related to trip length, but it is not certain yet if this change will be made.

But let us analyse to which extent the current fares are related with the distance travelled. Table 8.11 summarises the number of fare zones used in each metropolitan area, together with the population and area of the capital cities.

**Table 8.11: Population, Area and Fare Zones in Each Metropolitan Area**

Metropolitan area	Population (million)	Area (km <sup>2</sup> )	Fare zones
Gran Santiago	5.7	648	1 <sup>(a)</sup>
Greater London	7.3	1,560	6/1 <sup>(b)</sup>
Berlin	3.4	892	1 <sup>(c)</sup>
Madrid City	3.1	606	1
Madrid Region	5.7	8,028	6

<sup>(a)</sup> After *Transantiago's* implementation cheaper fares for local trips inside specific areas will exist, but fares will not be related with the number of zones travelled. <sup>(b)</sup> 6 zones for metro, DLR and rail, 1 zone for buses and trams. <sup>(c)</sup> Berlin is divided into two internal zones (A and B) plus a third peripheral zone (C), but inside Berlin tickets are offered only for zones A and B together.

**Santiago** has a single-zone flat fare, totally independent of the trip length. The implementation of *Transantiago* will introduce 10 different zones, but these are not fare zones as used in the European metropolitan areas, but local service zones, each one of them being operated by a different company. Longer trips travelling over several zones will be provided by the main bus services or metro lines, having a flat fare independent of the distance travelled. Nevertheless, there will be some relationship between trip length and fare, as local trips inside one local area using only local services will have a cheaper fare. This fare will be exactly the same in all areas and will also not depend on the distance travelled.

**Madrid** has 6 fare zones in the whole Region, but in Madrid City itself there is only one single zone, i.e. a flat fare.

The fare system in **Berlin** has three zones (A, B and C) with Berlin itself being divided into the fare zones A and B, whereas the additional fare zone C corresponds to the surroundings of Berlin. However no tickets for zone A are offered, being zone A+B the smallest zone available. The reason for the existence of zones A and B is explained by the fares for trips with origin or destination outside Berlin (in zone C). Those trips have a higher fare if they use the city centre (zone A) than if they only use zones B and C. So considering only the trips inside Berlin, i.e. trips with origin and destination in zones A or B, the fare structure is a flat fare. Moreover, the prices of the tickets for zones AB, BC and ABC are quite similar, with less than 20 % of difference. The only exception to this “almost” flat fare is a ticket valid for very short trips (*Kurzstrecke*) that allows travelling over 3 to 6 stops at a reduced fare (55 % of the normal single fare).

As explained before, there are 6 fare zones in Greater **London**, but these are not relevant for all public transport modes. Only the underground, DLR and national rail use the zone fares whereas buses and trams have a completely flat fare over all Greater London. Though, it has to be said that buses and trams are mainly used for shorter trips, because of their lower speeds in comparison to the underground, DLR and rail. While buses had an average commercial speed of 17 km/h, the figures for the underground, DLR and national rail were 32 km/h, 29 km/h and 56 km/h respectively. So in 2004, the average length of bus and tram trips was 3.8 km and 5.2 km, while the average trip length in the underground was 7.8 km (TfL, 2005d). Moreover, 80 % of the national rail trips were more than 10 km long, and from them 30 % more than 16 km long.

The cheapest tickets for travelling in the central zones of London are offered for fare zones 1 and 2. Again, as was the case in Berlin, tickets for the smallest zone 1 (alone) are normally not sold, although some exceptions exist in the case of single fares. The main reason for the existence of zone 1 is that travelcards and single tickets that do not use this zone are offered at cheaper prices than similar tickets that include zone 1, similar to the situation in Berlin. Zones 1 and 2 cover an estimated area of some 200 km<sup>2</sup>.

In Santiago, a high proportion of low income families live in the peripheral zones of the metropolitan area, as is typical in Latin-American and some African cities (Gwilliam, 2005 p2). Therefore, there are “**social**” arguments in favour of not charging higher prices for longer trips. However, these flat fares may yield poorer services in the periphery, as Gwilliam states, as operators could shorten their services. This is an interesting point that should be considered when making recommendations about flat or distance related fares. However, this negative impact of flat fares has not been observed in Santiago, even when bus services were completely deregulated in the 1980s. Given that public transport services are currently regulated and (mainly) defined by the authority, service shortening because of flat fares is highly improbable to occur.

Balcombe et al. (2004 p62) reports a case where a distance-related fare was changed into a flat fare in the Brighton area (England). They state that the scheme has been popular with passengers, as they now know exactly the cost of the fare. The scheme produced a year on year patronage growth of 8.5 %, in spite of the increase on the average fare that it meant.

And what does the **public transport pricing theory** say about this issue? A deep revision and discussion of the pricing theory in urban public transport services was made by

Gschwender (2000) and then summarised in Jara-Díaz and Gschwender (2005). About the relationship between fares and trip length, they show that a first theoretical analysis considering only the operators' costs yields that the optimal fare should increase with the trip length. However, this common analysis is not complete, because it ignores that beside the operators also the users supply an important input for the production of trips: their time. In fact, the inclusion of users' time in the analysis produces surprising results. In certain cases, even an optimal fare that decreases with the trip length is found (Jara-Díaz and Gschwender, 2005 p456). Therefore, the authors make the following recommendation:

“As there is no clear relationship between optimal fare and trip length for a given route, flat fares seem to be a good option. Moreover, a flat fare is easier and cheaper to implement. Nevertheless, if routes with different lengths exist, it may be reasonable to have higher flat fares on the longer routes because of operators' costs.” (Jara-Díaz and Gschwender, 2005 p457)

The fare structure (mostly flat fare) found in the three European capital cities analysed fits well with the previous recommendation. Moreover, the fare structure in Santiago both before and after *Transantiago* seems also to be concordant with the here very briefly described public transport pricing theory. Therefore, considering both the practical evidence and the theoretical arguments discussed above, the recommendation for Santiago is to maintain a mostly flat fare like the one designed for *Transantiago*. A completely flat fare would also be a good option.

#### 8.3.4 Reduced fares in specific periods or areas

In some of the metropolitan areas, the public transport fare structure includes reduced fares in specific periods or areas. From the four capital cities analysed only Madrid does not have **time-related reductions** in its public transport fares.

In the case of **Santiago**, the metro had a 20 % reduced fare in the off-peak periods. However this time-fare-differentiation should be ended with the introduction of the new integrated fare system of *Transantiago*, which does not consider time-related price reductions in the fare structure defined in the contracts. In **Greater London** there are 20 % to 45 % reduced single fares in buses, trams, underground and DLR in off-peak periods. Moreover 20 % to 50 % reduced one-day and 3-day travelcards are also available (on weekdays they can only be used after the morning peak period). **Berlin** also has a 26 % reduced monthly travelcard that allows travelling after 10:00 on weekdays and anytime at the weekends.

Interestingly, also **zone-related reduced fares** can be found in **Greater London**, where cheaper fares are available for trips that do not use the central zone of Greater London both for Tube/DLR single fares and monthly travelcards. For instance Tube/DLR single fares have a cost between € 2.3 and € 5.3 (depending on the number of zones) when using zone 1, and between € 1.5 and € 2.7 when not. The fare structure in Greater London clearly penalises the use of zone 1 through higher fares. This situation can be interpreted as an attempt to have higher prices in those parts of the lines where more demand exist, i.e. higher fares in the more congested sections of the public transport lines.

Although not so clear as in London, a similar situation is found in **Madrid**, in the case of the travelcard prices. A travelcard allowing trips in zones B1 and B2, but not in zone A (Madrid City) is 35 % cheaper than the travelcard valid for zones A, B1 and B2, 26 % cheaper than the A and B1 travelcard, and even 15 % cheaper than the travelcard for zone A. But in this case the difference is between the prices in Madrid City (zone A) and the surrounding areas of the region, not inside the capital city, as was the case in London.

In **Berlin**, the prices of tickets and travelcards including zones AB, BC and ABC are similar and in some cases tickets BC are even slightly cheaper than AB (e.g. daily travelcard). Nevertheless, a fare penalisation of trips using zone A cannot be clearly recognised. In the case of **Santiago**, neither before nor after the introduction of *Transantiago* can any form of zone-related reduced fares be recognised, in terms of cheaper fares in the more congested sections of the public transport lines.

### **Theoretical considerations and recommendations for Santiago**

There are two theoretical reasons why different fares should exist between **peak and off-peak periods**:

- Firstly, price-elasticity is normally lower (in absolute terms) in the peak than in off-peak periods, because there are more work trips in the peak, and work trips have usually lower price-elasticities (see Appendix A). Optimal pricing rules suggest that higher prices should be related with lower price-elasticities, according to what is known as the *Ramsey Pricing Rule* (Ramsey 1927; Gschwender, 2000 p65). Therefore, it does make theoretical sense to have lower fares in off-peak periods.
- Secondly, there is usually spare capacity in off-peak periods, yielding an almost zero marginal cost for an extra passenger. But even if more vehicles have to be added in the off-peak (e.g. to increase de frequency), the incremental cost is much lower than if more vehicles had to be added in the peak. This is so because extra vehicles in the peak mean that new vehicles have to be bought, and that new drivers have to be contracted, whereas extra vehicles to run in the off-peak may be already available (if more vehicles are used in the peak than in the off-peak) and drivers could also be partially available (Jansson, 1980; Gschwender, 2000 p46). So reduced fares in off-peak periods may offer an incentive to some passengers to change their trips from the peak to the off-peak, when operating costs are lower.

Thus there is a clear match between the pricing theory and the reduced fares in the off-peak found in some of the observed metropolitan areas. As a result, we recommend the implementation of different fares in peak and off-peak periods in the public transport system of Santiago. This could be done in the form of reduced fares in the off-peak and special fares for elderly valid only in off-peak periods (as existed in the metro before *Transantiago*), but also as reduced travelcards for off-peak periods, if travelcards are introduced in the future.

Both previous theoretical arguments could also be extended to the case of **reduced fares outside city centres**<sup>14</sup>. In fact:

- city centres usually concentrate work trips and
- the more congested sections of the public transport lines are also normally in the city centres.

However, higher fares in the centre of Santiago would only be applicable if a zonal fare system was introduced (like in London). This has not been considered in *Transantiago* and is also not recommended here. Therefore, we do not recommend the introduction of zone-related reduced fares in Santiago.

### **Critical analysis and impact estimation of time-related fare differentiation**

Interestingly, short before the implementation of *Transantiago* it was announced that the metro would have a 10 % higher fare in the peak hour<sup>15</sup>. The reason for this decision was the dramatic increase in the metro trips that the fare integration would produce. Eventually, its capacity could be exceeded in the peak periods. Therefore buses should complement the metro in that periods and the fare difference between buses (which would not have a higher fare in the peak hour) and the metro should give an incentive to some users to avoid using the metro. In this case, the main impact of the scheme should be in the modal split of the public transport, moving users from the metro to buses. A small impact in the time-of-travel decision may also occur (passengers changing the time of travel to avoid the higher fare in the metro).

A general price differentiation in the peak hour for all the public transport (buses and metro) as recommended above would not impact the public transport modal split, but would have a higher impact in the time-of-travel decision. In this case the main objective is to give an incentive to those who can change their time of travel to avoid peak periods.

It has to be emphasised that both previous schemes (higher fare in metro than buses and higher fare in peak hour than off-peak periods on all public transport) can be combined, to achieve a high impact both in the public transport modal split and in the time-of-travel decision. For example, the value of the fares could be:

- $P$  in off-peak periods in both buses and the metro
- $1.1P$  in peak periods in buses
- $1.2P$  in peak periods if using the metro

If peak and off-peak fares are to be differentiated, their new values should be calculated using adequate microeconomic pricing models. If the scheme is forced to have a neutral financial impact (which is highly probable in Santiago) and therefore maintain the revenue level, the peak fare would increase and the off-peak fare would decrease in comparison to the previous non-differentiated fare. Thus, users who normally travel in off-peak periods would benefit from a lower fare. On the contrary, the peak fare increase would produce a

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<sup>14</sup> It has to be emphasised that this zone-related price differentiation has absolutely no connection with the issue discussed above about the relationship between fare and trip length.

<sup>15</sup> And it was also announced that the reduced fare for elderly people would be maintained in the metro in off-peak periods.

direct disbenefit to the passengers who continue travelling in the peak. And those who change their time-of-travel would also perceive a disbenefit because of that time change. Additionally, it has to be taken into account that an increase in the public transport fare in the peak hour can also have an impact in the general modal split encouraging car use in the most congested hour.

What would be the impact in total demand and revenue of introducing a time-differentiated fare? This will of course depend on the extent in which the fares are changed. Nevertheless, a numerical exercise will help us to illustrate some interesting qualitative results. Let us assume an initial situation in which, for instance, 37 % of the public transport trips are made in peak periods and the other 63 % are made in off-peak<sup>16</sup>, with the same fare in both periods. If the peak fare is increased by 10 % and the off-peak fare is reduced by 5.9 %, the weighted average fare would be maintained. An estimation of the impact on demand that these changes produce can be made using price-elasticities for each period. We will use elasticity values in the middle of the ranges recommended by Litman (2004), both for the short and the long term (see Appendix A). As the demand will change, the total revenue will also be modified.

Table 8.12 shows the results for the short-term elasticity. The demand is reduced by 2.3 % in the peak period and incremented by 2.6 % in the off-peak, yielding an overall demand growth of 0.8 %. The revenue in the peak period is increased by 7.5 %, whereas the off-peak revenue decreases by 3.4 %. As the fare changes are higher than the demand variations (which have opposite sign), the impact of revenue has the same sign that the fare change in each period. The overall revenue is increased by 0.6 %.

**Table 8.12: Impact of Time-Differentiated Single Fare on Demand and Revenue (Short Term)**

Period	Initial trip distribution (%)	Fare change (%)	Price-elasticity	Impact on demand (%)	Impact on revenue (%)
Peak	37	10.0	-0.23	-2.3	7.5
Off-peak	63	-5.9	-0.45	2.6	-3.4
<b>TOTAL</b>	<b>100</b>			<b>0.8</b>	<b>0.6</b>

Source: own elaboration

Qualitatively, the same happens in the long term. But given the higher elasticities, the impacts on demand and revenue are more pronounced (table 8.13). In this case the overall demand growth is 1.5 % while the total revenue increases by 1.1 %.

<sup>16</sup> These figures correspond to the motorised trips on a weekday in Santiago according to the last origin-destination survey (EOD, 2001).

**Table 8.13: Impact of Time-Differentiated Single Fare on Demand and Revenue (Long Term)**

Period	Initial trip distribution (%)	Fare change (%)	Price-elasticity	Impact on demand (%)	Impact on revenue (%)
Peak	37	10.0	-0.5	-5.0	4.5
Off-peak	63	-5.9	-0.9	5.3	-0.9
<b>TOTAL</b>	<b>100</b>			<b>1.5</b>	<b>1.1</b>

Source: own elaboration

This exercise shows that it is possible to increase both the demand and the revenue through the implementation of different fares in peak and off-peak periods. In general, an overall demand increase can be expected as a result of the fare differentiation between peak and off-peak periods because of the relative values that the price-elasticities have in those periods: Although the exact values may vary, the price-elasticity is always lower in the peak hour (when the fare increases) than in the off-peak (when the fare decreases), as explained above in this section.

Although the fare changes of the numerical exercise were determined maintaining the weighted average fare (weighted considering the initial peak and off-peak trip distribution), a revenue increase was obtained due to the overall demand increase. However, this revenue increase does not necessarily happen for every fares selected. As further numerical simulation showed, the overall revenue decreased when the fare changes (always maintaining the weighted average fare) were large enough. How large the fare changes need to be depends on the relation between the peak and off-peak elasticities. If they are very different, a very large fare change is needed. But the opposite occur if they are closer. For example, if the peak elasticity is -0.40 and the off-peak elasticity is -0.45, the same fare changes used in the previous exercise (10 % increase in the peak fare and 5.9 % decrease in the off-peak fare) are enough to produce an overall revenue decrease.

Finally, there seem to be no technical problems for the implementation of a time-differentiated single fare in Santiago. The fact that different fares in peak and off-peak periods will exist in the metro shows that the electronic smartcard used in Santiago is able to provide this kind of schemes.

Political difficulties may arise, but at a much smaller extent than in the case of the travelcard, because the concept of higher prices in peak periods is known at the decision-making level. Nevertheless, the argument of “why should the user pay more (in the peak hour) when the service is worse (higher congestion)” has been repeatedly used in opposition to the higher peak prices charged in the new urban highways in Santiago, and would surely also be used in opposition to the here proposed scheme. However, time-differentiated prices exist in Chile in several other public services (e.g. telephone, electricity, water) and they are completely accepted. Moreover, higher peak-fares have been applied in the metro for more than 15 years.

From the users' viewpoint, the fare structure would become more complicated. But users are already familiar with this scheme in the metro and therefore they should not have serious problems to accustom themselves to a time-differentiated fare in all public transport modes.

### 8.3.5 Average fare

Now we want to compare the fares of the public transport in the analysed metropolitan areas. Which capital city has the more expensive (for the user) system? How does this change if we include into the analysis the facts that

1. the disposable income of the people varies in the different metropolitan areas and
2. the acquisition power of the money also varies among them?

In order to do that, we will compare the average fares in the different metropolitan areas.

The easiest way to calculate the average fare is by dividing the total fares' revenue by the number of public transport trips (table 8.14). By doing so the average fare includes all type of fares: single fares and travelcards. The average fare in Santiago is slightly lower than the average fares in Berlin and Madrid, whereas the average fare in London is almost twice as high as the others.

**Table 8.14: Average Fare** <sup>(a)</sup>

Metropolitan area	Yearly public transport trips (million)	Revenue from ticket sales (million €/year)	Average fare (€)	Average fare (US\$)
Santiago	1,400 <sup>(b)</sup>	570 <sup>(c)</sup>	0.41	0.49
Greater London	3,189	2,805	0.88	1.06
Berlin	1,205	N/A	0.52 <sup>(d)</sup>	0.62 <sup>(d)</sup>
Madrid Region	1,514	797	0.53	0.63

<sup>(a)</sup> Data for years 2002 to 2004 <sup>(b)</sup> Shared-taxi trips not included. <sup>(c)</sup> Estimation. <sup>(d)</sup> Estimated only for BVG: 906 million trips in 2004 (BVG, 2005b p3) and 468 million EUR fare income in the same year (SfS, 2006b p7)

Source: own elaboration based on data of the previous chapters

Given the important difference in the GDP per capita of Santiago and the three European capital cities (see table 8.15), it is interesting to include in the analysis of the average fare the effect of this difference. The idea is to compare the relation between the average fare and the average disposable income of the population, taking the GDP as a proxy for the disposable income. This gives an idea of how expensive the public transport is in relative terms. To do that, we assume a fictitious user that makes a certain amount of yearly public transport trips (for instance 600 trips/year) and calculate his total yearly expenditure in public transport fares, supposing that he pays the average fare. Then we divide this expenditure by the GDP per capita, yielding the relative importance of the average fare in the GDP per capita. It has to be emphasised that the aim of this analysis is not to accurately estimate the expenditures in mobility, but just to compare the relative fares in the different metropolitan areas.

The results are presented in table 8.15. It can be seen that **when the nominal GDP per capita is taken into account**, the average fare in Santiago appears hugely higher than the average fares of the three European capital cities. The expenditure of our fictitious traveller represents 4.2 % of the GDP per capita in Santiago, in comparison to only 1.7 %, 1.1 % and 1.4 % in London, Berlin and Madrid respectively. Normalising with respect to Santiago, it can be seen in the last column that the average fares in London, Berlin and Madrid vary between 26 % and 42 % of the average fare in Santiago, when considering the disposable income of the population (using the GDP as a proxy).



**Table 8.15: How Expensive is Public Transport in Each Metropolitan Area? – Nominal GDP**

Metropolitan area	GDP (nominal) per capita 2005 <sup>(a)</sup> (US\$)	Average fare (US\$)	Average fare * 600 / GDP per capita	
			%	Normalised
Santiago	7,040	0.49	4.2	100
Greater London	36,599	1.06	1.7	42
Berlin	33,922	0.62	1.1	26
Madrid Region	27,226	0.63	1.4	33

<sup>(a)</sup> Source: International Monetary Fund (2006a)

But the analysis so far does not consider the different acquisition power of the money in the different countries. It is well known that one Euro may allow buying more things in one country than in another. To take this effect into account, economists developed purchasing power parity (PPP) exchange rates, which equalise the purchasing power of different currencies. One very simple example of an index that measures the PPP is the Big Mac index, introduced by *The Economist* newspaper in 1986. Instead of considering a basket of goods that can be bought in the different places, this informal index only considers the price of a single Big Mac, as sold by the McDonald's fast food restaurant chain (University of British Columbia SSB, 2007).

Table 8.16 shows the Big Mac index, i.e. the price of a Big Mac hamburger in the four metropolitan areas (The Economist, 2006) converted from the local currency to US\$. The idea of the index is that you can buy exactly the same product (a Big Mac) in Santiago for US\$ 2.94 and in London for US\$ 3.65. Thus the purchasing power of a US\$ is higher in Santiago than in London. In fact, US\$ 2.94 in Santiago is equivalent to US\$ 3.65 in London. Using this index, it is possible to correct the comparison of the average public transport fares. This can be done by simply dividing the fares by the respective Big Mac index and comparing the results.

**Table 8.16: How Expensive is Public Transport in Each Metropolitan Area? – Big Mac Index**

Metropolitan area	Average fare (US\$)	Big Mac index May 2006 (US\$)	Average fare / Big Mac index	Average fare / Big Mac index (normalised)
Santiago	0.49	2.94	0.166	100
Greater London	1.06	3.65	0.289	174
Berlin	0.62	3.77 <sup>(a)</sup>	0.164	99
Madrid Region	0.63	3.77 <sup>(a)</sup>	0.168	101

<sup>(a)</sup> The Big Mac index presents a single value for the entire Euro zone

After dividing the average fares by the respective Big Mac index and normalising (last column in table 8.16) the average fares are surprisingly similar in Santiago, Berlin and Madrid, but some 74 % higher in London, **after correcting the average fares in order to include the effect of the different acquisition power of the local currencies** (through the use of the simple and informal Big Mac index).

Finally, it is possible to include both previous corrections in the comparison of the average public transport fares: first the inclusion of the GDP per capita and second the inclusion of

the purchasing power of the local currency. This can be done using the GDP per capita at purchasing power parity (PPP) that is estimated by the International Monetary Fund, which reflects the cost of living in the different countries as explained before. GDP (PPP) is calculated in “international dollars”, a hypothetical unit of currency that has the same purchasing power that the U.S. dollar has in the United States. The international dollar shows how much a local currency unit is worth within the country’s borders (World Bank, 2007).

The same procedure used in table 8.15 is used now in table 8.17, but considering the GDP per capita at purchasing power parity. The results of this table show that **when the disposable income of the population** (using the GDP as a proxy) **is taken into account together with the purchasing power of the local currency**, the average fare in Santiago is still higher than the average fares of the three European capital cities. Now the average fares in London, Berlin and Madrid are between 50 % and 85 % of the average fare in Santiago, as can be seen in the last column.

**Table 8.17: How Expensive is Public Transport in Each Metropolitan Area? – GDP (PPP) <sup>(a)</sup>**

Metropolitan area	GDP (PPP) per capita 2005 <sup>(b)</sup> (international US\$)	Average fare (US\$)	Average fare * 600 / GDP per capita	
			%	Normalised
Santiago	11,937	0.49	2.5	100
Greater London	30,470	1.06	2.1	85
Berlin	30,579	0.62	1.2	50
Madrid Region	26,320	0.63	1.4	59

<sup>(a)</sup> Gross domestic product (GDP) per capita at purchasing power parity (PPP) is used. <sup>(b)</sup> Source: International Monetary Fund (2006a)

This exercise clearly refutes a wrong belief that is common in Santiago, namely that the fares of its public transport system are lower than the fares of the public transport in European metropolitan areas. This wrong idea comes from a too superficial analysis: the simple comparison of the single fares (which actually are higher in Europe than in Santiago) without considering the importance of European travelcards that give frequent travellers a better value for money. But as table 8.14 and table 8.16 show, the average public transport fares (including both single tickets and travelcard users) are very similar in Santiago, Berlin and Madrid. And when the GDP per capita is included in the analysis (as a proxy of the disposable income) the average fare in Santiago is even higher than in London. This happens mainly because of the lower GDP per capita in Santiago, both when considering the nominal GDP (table 8.15) and the GDP at purchasing power parity (table 8.17). Comparing only the European metropolitan areas, London presents a higher fare than Berlin and Madrid under all the analyses made.

### 8.3.6 Subsidies and financial equilibrium

The public transport systems in London, Berlin and Madrid receive important subsidies for their operation (table 8.18). This is not the case in Santiago, where there is no operational subsidy and the public transport system (buses and metro) has to cover all its operational costs through fares incomes and other minor incomes (e.g. publicity). The absence of

operational subsidies for urban public transport is a common situation in Latin-American countries, especially in metropolitan areas without urban rail systems. This is a political decision that has normally to be considered as a border restriction for public transport planning. In the case of Santiago, the last operational subsidies were received by Metro in the 1990s. Metro reached financial equilibrium covering its operational costs without financial support by the central government, as wanted by the economic policies of the government. Private bus operators did not receive subsidies, at least not in the last 30 years. The new integrated public transport system *Transantiago* does also not consider any financial support for the operation of the services.

**Table 8.18: Operation Costs, Fare Revenues and Subsidies**

Metropolitan area	Year	Operation costs (€ mill./year)	Revenue from ticket sales (€ mill./year)	Subsidies (€ mill./year)	Relation between subsidy and operation costs (%)
Santiago	2003	N/A	570 <sup>(a)</sup>	0	0
Greater London <sup>(b)</sup>	2003	7,200	3,450	4,200	58
Berlin <sup>(c)</sup>	2004	994	468	420	42
Madrid Region	2003	1,255	623	667	53

<sup>(a)</sup> Estimation. <sup>(b)</sup> Data for Transport for London including street management and infrastructure investment. <sup>(c)</sup> Data for BVG (underground, buses and trams)

Source: own elaboration based on data of this and previous chapters

But there are good **economic justifications** for public transport operational subsidies. Jara-Díaz and Gschwender (2005) show that a careful optimal pricing analysis in urban public transport yields lower optimal fares than the average cost, implying that a subsidy is necessary. This happens because the relevant cost (users' and operators' costs) increases less than proportional with the demand, i.e. there are decreasing average costs and scale economies. The underpricing of cars, an alternative mode, is an additional argument in the direction of public transport subsidy. So public transport subsidies should not be seen only as a burden on the public budget, but also as a correct (economically justified) decision.

The high levels of subsidy in the reviewed European capital cities (about 50 % of the operational costs) make it very difficult to imagine how public transport could be operated without subsidies. But this actually happens in many Latin-American metropolitan areas. How is it possible for public transport systems there to operate without subsidies? One possible explanation could be the typically worse quality of public transport in Latin-America (e.g. older vehicles). However there are at least a few examples of high quality services in Latin-America that also operate without subsidy, for instance the metro in Santiago, and the Bus Rapid Transit system *Transmilenio* in Bogotá, Colombia.

In addition to the lower quality of the public transport systems in Latin-America, there are other reasons that explain why it is possible there to operate without subsidies:

1. **Labour costs** are cheaper in Latin-America than in Europe, and labour costs are an important part of the operating costs of a public transport company. For example, in Santiago the costs of drivers represent about 30 % of the total operating costs of the bus system (Sectra, 2003), whereas in Germany drivers can represent up to 70 % (Leuthardt, 1998) of the total costs (in both cases including the capital costs of the vehicles).

2. The **vehicles** used in Latin-America are normally cheaper than those used in Europe, because of different technological standards, for instance, high-floor vehicles in Latin-America and low-floor vehicles in Europe.
3. The **occupancy factor** of the public transport vehicles in Latin-America is higher than in Europe due to the acceptance of higher crowding levels inside the vehicles there. Comfort inside public transport vehicles receives much more attention in Europe than in Latin-America. For instance, CRTM in Madrid has the aim of reducing passenger density inside their vehicles to 3.5 people/m<sup>2</sup> (Cristóbal-Pinto, 2005), while values of up to 6 people/m<sup>2</sup> are typically considered in Latin-America. Moreover, high-capacity systems (e.g. metro) are much wider provided in the European metropolitan areas than in Latin-America. The European metropolitan areas accept to build metro lines in corridors with much lower demands than what would be necessary for a Latin-American metropolitan area to invest in a high-demand rail system. In addition, a higher **population density** in Latin-American metropolitan areas could also help explaining the possibility of zero operational subsidies for the public transport.

It is often wrongly argued that the total demand for public transport is higher in Latin-American metropolitan areas than in Europe. However, the total demand for public transport and the number of public transport trips per inhabitant are not higher in Santiago than in the European capital cities reviewed, as we showed in section 6.2.

### **Subsidies in Santiago?**

The fact that operational subsidies for public transport are given in European metropolitan areas can be understood as a recognition of their economic justification, and also as an explicit policy decision in order to promote the use of public transport (obviously the subsidies allow a better quality of the system). Because of these reasons, operational subsidies for the public transport are also recommended here for Santiago.

However, the political opposition to a direct subsidy for the operation of public transport in Santiago would be huge. It cannot be ignore that there is a general economic policy in Chile that tries to avoid direct subsidies as much as possible. For example, the fact that Metro does not receive operational subsidies since the 1990s is seen as a great success of the company. Even more, Metro is increasingly financing part of the new infrastructure (new metro lines). The absence of an operational subsidy and the partial financing of its new infrastructure are perceived as extremely positive characteristics of Metro. Both characteristics obviously have an impact in the users' fare.

In the case of the bus system, users will also pay part of the new infrastructure for *Transantiago*. For instance, some segregated busways are being built through public-private partnerships, in which a concessionary has to finance and construct the works and then maintain it over some period (e.g. 20 years). The payments that the private concessionary will receive over the concession period are fully charged to the public transport fare. There are even cases in which a cross-subsidy from public transport users to car users exist, because the works will benefit both the public transport and the private car, but will be paid only by the public transport fare. The regressive characteristic of this cross-subsidy is

evident, as public transport users in Santiago mostly belong to medium and low-income families.

In the author's opinion, there seems to be some kind of implicit agreement between the main political parties in Chile about avoiding direct subsidies<sup>17</sup> in order to reduce "unnecessary" fiscal expenditure. This consensus applies not only to transport policies. But at the same time, a cross-subsidy is absolutely not a matter of concern as far as it does not affect fiscal expenditure.

Thus a direct operational subsidy for the public transport is very unlikely to be accepted at the decision-making level in the short term. Nevertheless, its convenience and justification have to be highlighted in order to increase the possibility of its implementation in the medium or long term. A more likely alternative for the short term could be a "cross-subsidy" for the public transport that would not imply a direct fiscal expenditure.

### **Cross-subsidies for the public transport**

A possibility to introduce a subsidy in Santiago could arise if a congestion-charging scheme similar to the one in London is introduced. Such a scheme is being studied in the transportation planning agencies, although no political decision exists yet. If it is introduced, the revenues of the congestion charging (or at least a part of it) should be used to improve the public transport system implying a cross-subsidy from car users to the public transport, as is the case in Greater London. This would help those users that decide not to use the car anymore because of the charge, giving them better public transport services. In addition, an improvement of the public transport services through this subsidy would complement the congestion-charging scheme, because users facing a better public transport AND a more expensive private transport will probably be more willing to change to public transport.

But the implementation of congestion charging in Santiago would not be an easy task. Again, the main difficulty would be at the political level, where generalised opposition already made fail a similar initiative presented by the government to the congress at the beginning of the 1990s, after several years of analysis and discussion. Now, the fact that a world-metropolis like London successfully operates a congestion-charging scheme would surely be very helpful in order to convince the decision-makers about the convenience of the measure.

Another interesting idea to finance a subsidy for the operation of the public transport was found in London. It was proposed there that penalty charges for enforcement of traffic rules could be partially used to finance public transport (e.g. penalties to cars using bus lanes), generating a cross-subsidy in benefit of public transport. This would require a law modification and is therefore neither easy nor quick to implement in Santiago. Nevertheless, the author believes that this measure could have a better chance to succeed in comparison to the other discussed so far.

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<sup>17</sup> The political parties from which the author would expect opposition to the idea of a direct subsidy for the operation of public transport received almost 85 % of the votes in the last parliamentary election in 2005 (*diputados*). This represents both the parties in the government and in the conservative opposition.

### **Cross-subsidies “against” the public transport**

On the other hand, regressive cross-subsidies that have a negative impact on public transport users should be avoided. The case of infrastructure paid by public transport users that also benefit car users was already discussed above.

Another regressive cross-subsidy exists in Santiago in the case of the reduced fares for students. Public transport operators receive no compensation for these lower fares implying a cross-subsidy between passengers paying the full fare and those that pay the reduced fare. But public transport users paying the full fare are mainly poorer people (those who do not have a car), whereas students, especially at the higher educational levels (e.g. universities), come mainly from middle and high-income households. Thus it can be seen that this cross-subsidy is regressive<sup>18</sup>.

This issue is solved in a very simple way in other metropolitan areas. For example, the public transport system of Berlin receives an explicit subsidy because of the existence of reduced fares for certain groups (e.g. students and disabled people). The BVG (operator of metro, tram and buses in Berlin) received € 91 million from the Federal State of Berlin through this subsidy in 2004, as a compensation for the reduced fares offered (BVG, 2004j, 2006e pp25-26).

Following this experience, we recommended here to maintain the reduced students' fare in Santiago, but incorporating an explicit compensation for the public transport system, in order to eliminate the regressive cross-subsidy. To achieve this, this regressive cross-subsidy needs to be clearly identified and made known first. The decision-makers in Santiago seem not to be aware of its existence and as long as this unconsciousness remains, it will be impossible to correct the problem. But if it is recognised and understood, there should be a political interest in finishing it. In fact, the correction of this regressive cross-subsidy, even if it requires a direct subsidy from the government, seems to be much more feasible than the implementation of a general subsidy for the public transport. In order to increase the success probability of this measure, it should be highlighted that this is a subsidy for the educational system, i.e. a subsidy that benefits students and schoolchildren, and not a subsidy for the public transport operators. Given that subsidies for the educational system are common in Chile, this should be easier to accept at the decision-making level.

### **Impacts on demand and additional comments**

A subsidy for the operation of the public transport in Santiago would have a positive impact on demand. If the subsidy is totally used to reduce the fare, its impact on demand could be estimated using the fare elasticities reviewed in Appendix A. This impact would obviously depend on the subsidy level.

As an example, let us assume a subsidy of 10 % of the total fare revenue, which is estimated in € 570 million per year (table 8.18). This would imply a subsidy of € 57 million per year. If it is totally used to reduce the fares, it can be assumed that all fares will be

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<sup>18</sup> A similar situation is described by Gwilliam (2005 p2) for the metropolitan area of Dakar in Senegal, where middle class students were found to be the main beneficiaries of reduced fares. There, the imposition of reduced fares without direct compensation to the operator had a negative effect on service quality.

reduced by 10 %. Assuming fare-elasticity values in the middle of the ranges recommended by Litman (2004), the impact on demand is an increase of 3.5 % in the short term and 7.5 % in the long term (table 8.19). In absence of a demand growth, the fare revenue with the reduced fare would obviously be 90 % of the initial figure. But as the demand increases, the final fare revenues are higher than that: 93.2 % in the short term and 96.8 % in the long term. As a result, the total income (fare revenue + subsidy) has an increase of 3.2 % (€ 18.0 million per year) in the short term and 6.8 % (€ 38.5 million per year) in the long term.

**Table 8.19: Impact of a Subsidy on Demand and Revenue (Overall Fare Changes)**

Term	Subsidy (%)	Fare change (%)	Price-elasticity short term	Impact on demand (%)	Final fare revenue (%)
Short term	10.0	-10.0	-0.35	3.5	93.2
Long term	10.0	-10.0	-0.75	7.5	96.8

Source: own elaboration

The demand growth would also imply that the capacity of the system would have to grow (more vehicles, more frequency). Therefore, at least part of the higher income would have to be used to increase the capacity.

To avoid the necessity of important service expansions (and their costs), the subsidy could be used to reduce the off-peak fare only. Assuming that 63 % of the trips are made in off-peak periods and that the same subsidy is provided (€ 57 million per year), the off-peak fare has to be reduced by 15.9 % to “compensate” the subsidy and maintain (initially) the total income<sup>19</sup>. Following the same procedure as for the example above, the demand increases (only in off-peak periods) in the short and long term are estimated (table 8.20), yielding slightly higher final fare revenues than in the previous case. Now the total income (fare revenue + subsidy) has an increase of 3.8 % (€ 21.6 million per year) in the short term and 7.6 % (€ 43.2 million per year) in the long term. But as only off-peak demand increased in this example, the cost of the necessary service expansions would be much lower than in the case of an overall fare reduction. Therefore, the extra funds could be used to improve the quality of the service.

**Table 8.20: Impact of a Subsidy on Demand and Revenue (Off-Peak Fare Changes)**

Term	Subsidy <sup>(a)</sup> (%)	Fare change (%)	Price-elasticity short term	Impact on demand (%)	Final fare revenue (%)
Short term	10.0	-15.9	-0.45	7.1	93.8
Long term	10.0	-15.9	-0.90	14.3	97.6

<sup>(a)</sup>: As a percentage of the total fare income previous to the subsidy

Source: own elaboration

The reduction in the off-peak fare could have an impact in the peak demand (some passengers could change their time-of-travel). However, this effect is ignored in this example, as only an off-peak fare-elasticity is used. A cross-elasticity representing the

<sup>19</sup> A 15.9 % reduction in the fare paid by 63 % of the trips yields a revenue decrease of 10 % ( $0.159 \cdot 0.63 = 0.1$ )

impact on peak demand of an off-peak fare change would be needed to take this effect into account.

It has to be noticed, that a subsidy could also be used to directly improve the service (instead or in addition to a fare reduction). Special attention should be put in the possibility of increasing the frequencies of bus services in order to reduce the occupation levels of the public transport vehicles. This is important because comfort will become more and more important for public transport users, as income and motorisation rates increase. In fact, the number of captive public transport users will continue decreasing, and travellers will become more sensitive to crowding inside the vehicles. The European experiences show that their successful public transport systems have lower passenger densities inside the vehicles than typically accepted in Latin-American metropolitan areas.

The way in which an operational subsidy is given has to be carefully designed, in order to avoid negative incentives. For example, as stated by Jara-Díaz and Gschwender (2005 p458), various authors found that a subsidised public transport operation may increase operational costs, because of higher salaries and productivity reductions (Bly et al., 1980; Pucher and Markstedt, 1983; Anderson, 1983).

### 8.3.7 Conclusions

Travelcards as found in London, Berlin and Madrid should be included in the public transport fare system of Santiago. They usually have a very positive impact on public transport patronage. However, the expected impact in Santiago is lower than in other metropolitan areas because some of the benefits of travelcards were already achieved by the massive introduction of an electronic smartcard.

Evidence suggests that it is possible to find appropriate fare levels (for travelcards and single tickets) to make both users and operators better off, avoiding a negative financial impact for the operators due to the introduction of travelcards. Given the low price-elasticity of travelcards, it is recommendable to introduce them at a low initial price to achieve a quick market penetration, and later increase their cost to reach the desired long-term price. By doing so, a higher market share should be achieved than if the long-term price was charged from the beginning.

The integrated fare system, electronic smartcard and charging network introduced by *Transantiago* allow an easy implementation of travelcards, from a technical viewpoint. However, some difficulties were detected for its implementation, mainly in terms of expected unwillingness at the decision-making level.

In the short-term other forms of price incentives for frequent users could be provided in the public transport of Santiago. For instance, a reduced fare could apply after the passenger reaches a certain amount of trips in one month. This could be easily done thanks to the technology of the smartcard that will be used in *Transantiago*. However, the benefits of this fare reduction are expected to be much limited than the ones resulting from the introduction of travelcards.



Public transport fares in London, Berlin and Madrid use concentric zones. Nevertheless, Berlin and Madrid actually have flat fares inside the main urban areas and the zonal fare system in London does not apply for buses, which also have a flat fare. Theoretical evidence suggests that a flat fare should be preferred inside an urban area, instead of distance-related fares. In Santiago there is also a "social" argument for flat fares because many low-income households are situated in the periphery of the metropolitan area. Therefore we recommend maintaining the mostly flat fare introduced with *Transantiago*.

Reduced fares in the off-peak period exist in London and Berlin, in agreement with the theoretical evidence. The public transport system of Santiago should include time-related price differentiations in the future as well. This could be done through differentiated single tickets and also through reduced travelcards allowing travel only after the morning-peak, as used in London and Berlin. A numerical exercise helped showing that it is possible to increase both demand and revenue when different fares are introduced for peak and off-peak periods.

Time-differentiated single fares would be technically simple to implement. Moreover, no serious difficulties seem to exist at the decision-making level for its implementation, and users' should be able to quickly become familiar with them.

The average public transport fares (including both single tickets and travelcard users) are very similar in Santiago, Berlin and Madrid, but higher in London. When the gross domestic product (GDP) is included in the comparison (as a proxy of the disposable income) the average fare in Santiago becomes even higher than in London. This happens because of the lower GDP per capita in Santiago. Thus public transport expenditure represents a higher proportion of the available income in Santiago than in the European metropolitan areas.

Unlike Santiago, the public transport systems in London, Berlin and Madrid receive important operational subsidies. This kind of subsidies is fully justified by the economic theory in the case of urban public transport and also represent a clear policy decision of promoting the use of public transport. Therefore it is recommended here to introduce subsidies for the operation of the public transport system in Santiago, as shown in a numerical example. However, an important political opposition to this measure is expected, as it would imply a fiscal expenditure. Therefore, the possibility of financing the subsidy through other sources is especially interesting (congestion charging, enforcement of traffic rules). On the other hand, an explicit subsidy should replace the current regressive cross-subsidy between full-fare-payers and students.

## 9. Conclusions

### 9.1 Comparison between the Metropolitan Areas

An important part of this research was the presentation and comparison of the socio-economic and transport data of the four analysed metropolitan areas (Santiago, London, Berlin and Madrid). The socio-economic comparison yielded an important difference not only in the average income of the population, but also in the distribution of the income among them. Santiago has a lower income per capita, and in addition the distribution of its income is more regressive, i.e. it is more concentrated in the high-income groups than in the European cases (table 9.1). Mainly as a result of this, the motorisation rate in Santiago is lower than in Europe. Nevertheless, it has increased rapidly in the last decades, following the increase of the per capita income.

**Table 9.1: Summary of Main Socio-Economic Characteristics <sup>(a)</sup>**

Metropolitan area	Population (million)	Average family size	Per capita annual GDP (US\$)	Inequity Index <sup>(b)</sup>	Motorisation rate (cars per 1,000 inhab)	Area (km <sup>2</sup> )	Density (people per km <sup>2</sup> )
Santiago	5.9	3.8	7,040	40.6	148	860	6,900
Greater London	7.5	2.4	36,599	13.8	344	1,579	4,750
Berlin	3.4	1.8	33,922	6.9	327	892	3,810
Madrid Region <sup>(c)</sup>	6.0	2.9	27,226	9.0	550	8,028	750

<sup>(a)</sup> Data for 2005 except motorisation rate (2001/2002). <sup>(b)</sup> Average income of the richest 10 % divided by the average income of the poorest 10 %. <sup>(c)</sup> Madrid City has 3.2 million inhabitants, a surface of 606 km<sup>2</sup> and 5,280 people/km<sup>2</sup>.

The modal split between private and public transport was similar in the four metropolitan areas, with some 50 % of the trips in each subsystem. Santiago and Madrid had a slightly higher public transport modal split, whereas London and Berlin had a slightly higher private car proportion (table 9.2).

Interestingly, it could be shown that the public transport demand in Santiago is not higher than in the selected European metropolitan areas, as is commonly believed in Santiago. On the contrary, Santiago has a lower rate of public transport trips per inhabitant than London and Berlin. Only Madrid presents a slightly lower figure than Santiago.

**Table 9.2: Summary of Main Public Transport Characteristics**

Metropolitan area	Public transport modal split <sup>(a)</sup> (%)	Yearly public transport trips per inhabitant	Number of buses	Metro network (km)	Tram network (km)
Santiago	57	291	8,000	83	-
Greater London	44	437	6,800	435	28
Berlin	42	354	1,426	144	188
Madrid Region	53	275	1,494	227	-

<sup>(a)</sup> Considering motorised trips only

London, Berlin and Madrid have larger rail systems than Santiago. The first metro line was built in London in 1863, in Berlin in 1902 and in Madrid in 1919, whereas Santiago started the construction of its metro only in 1965. Although having a smaller network, the quality of the metro service in Santiago is comparable to the quality of the services in the selected European metropolitan areas. However, the bus system is clearly of lower quality in Santiago. This can be explained by the organisation of the bus system which includes bad practices like on-the-street competition. Hence the improvement of the bus system is an urgent task in Santiago. The imminent implementation of a major restructuring scheme of the bus (and metro) system under the name “*Transantiago*” seems to be a step in the right direction, because the main problems of public transport in developing countries need to be solved by comprehensive reorganisation and institutional improvements.

*Transantiago* should be in operation by 2007 and will reduce the number of buses in Santiago to approximately 5,000. Bus lines will be divided into main lines and feeder lines, and an integrated fare system will be implemented (also including the metro). The recommendations for the improvement of the public transport system of Santiago drawn in this research assume that *Transantiago* is already in operation.

## 9.2 Institutional Organisation of the Public Transport

The comparison of the institutional organisation of public transport in the four metropolitan areas showed another important difference between Santiago and the selected European capital cities. The absence of a public transport authority in Santiago was a key problem. The analysis of the European experiences allowed interesting conclusions and recommendations for Santiago.

The term “(public) transport authority” is usually used in reference to the following two similar related concepts, which have to be distinguished:

1. The political authority that is responsible for (public) transport issues.
2. Its technical and administrative office, which is in charge of implementing the policies and plans defined by the political authority and assists it in the creation of these plans.

Currently, the president of Chile is the political transport authority in Santiago, as he is the only elected authority accountable for the complete metropolitan area. In fact, the regional authority is not elected but appointed by the president and has almost no responsibility in transport issues. The mayors, who are directly elected, are responsible for small areas of the metropolitan area (there are more than 30 municipalities and mayors in Santiago). The transportation responsibilities of the municipalities are mainly administrative: maintenance of the local road network (smallest streets), installation and maintenance of the street furniture at bus stops and permissions for the installation of private bus depots.

Different ministerial offices are partially responsible for the main transport-related issues. The transport and telecommunications ministry (*Ministerio de Transporte y Telecomunicaciones*, MTT) is responsible for transport policies in Chile, including the

metropolitan areas and its public transport. Its regional secretary is responsible for the regulation of the bus system in Santiago. The traffic control operative unit (*Unidad Operativa de Control de Tránsito*, UOCT), dependent on the MTT, manages all the traffic signals of Santiago. The public works ministry (*Ministerio de Obras Públicas*, MOP) is responsible for the construction and maintenance of interurban roads, including several highways constructed inside Santiago in the last years. The housing and urban planning ministry (*Ministerio de Vivienda y Urbanismo*, MINVU) is responsible for the maintenance of the rest of the urban roads through its regional secretary. Together with the municipalities, MINVU is also responsible for land-use planning: the municipalities at the local level, and MINVU at metropolitan and regional levels. In addition there are three relevant inter-ministerial coordinating commissions: SECTRA (responsible for transportation strategic planning), CONASET (responsible for security issues in the transport system) and *Transantiago* (responsible for the implementation of the new integrated bus and metro system).

The president of the country is the only single authority above all public bodies with transportation responsibilities in Santiago. Having studied some examples of international experiences, a citywide or metropolitan authority seems to be more suitable than a countrywide authority to handle the transportation issues in a large metropolitan area.

The three European metropolitan areas analysed present different institutional solutions for the organisation of its transport system. Transport for London (TfL) is the local authority responsible for the transport system in the capital of the UK since 2000. It is accountable to the Mayor of London and is responsible for delivering the Mayor's transport strategy. TfL manages London's buses, the underground, the Docklands Light Railway and London's trams. It also runs London River Services, Victoria Coach Station and London's Transport Museum. Although TfL is not directly responsible for national rail services, a partnership has been established with the Strategic Rail Authority to develop national rail's contribution to an integrated public transport system in Greater London. In addition, the responsibility for the management of the rail services known as the North London Railway will be transferred to TfL by 2007. As well as running the central London congestion-charging scheme, TfL manages a 580 km network of main roads (including 900 bridges and 10 major tunnels), all of London's 4,600 traffic lights and regulates taxis and the private hire trade. TfL also coordinates schemes for transport users with mobility impairments as well as running the Dial-a-Ride scheme. In addition, TfL undertakes works in order to improve conditions for walkers, cyclists, drivers and freight and to implement proposals for reducing congestion on Greater London's streets. Nearly all issues of transportation are handled by TfL.

*Consortio Regional de Transportes de Madrid* (CRTM) is the local authority responsible for the public transport system in the Madrid Region. CRTM is an autonomous agency of the Regional Government (*Comunidad de Madrid*). It was created in 1985 as a unique public transport authority, gathering responsibilities of the Madrid Region and the adhered local governments. At the end of 2004 a total of 176 Municipalities, representing practically the entire population of Madrid Region, belonged to CRTM. The main functions of CRTM are the planning of transport services and the definition of coordinated operating programmes for all public transport modes, the establishment of an integrated fare system for all the different public transport modes, the planning of public transport infrastructures and the creation of an overall image for the public transport system.

There are two main operators in the public transport system of Berlin: the *Berliner Verkehrsbetriebe* (BVG) and the *S-Bahn Berlin GmbH* (S-Bahn). The BVG operates 161 bus lines, 9 underground lines, 27 tram lines and 6 ferry services and is a public company owned by the city of Berlin. The S-Bahn is totally owned by the *DB Regio AG*, part of the *Deutsche Bahn AG*, the former German public train operator, which began a long privatisation process in 1994. It operates 14 urban rail lines in Berlin. A public transport authority called *Verkehrsverbund Berlin-Brandenburg* (VBB) exists in Berlin and the surrounding region of Brandenburg since 1996. The VBB is a private company run in co-operation by the federal states of Berlin and Brandenburg, 14 municipal districts (*Landkreise*) and 4 towns (*kreisfreie Städte*) of Brandenburg. The main tasks of the VBB are the coordination of the services run by the 43 public and private owned public transport companies, the introduction and development of a common fare system for all companies in the VBB area, the improvement, standardisation and quality control of public transport services, the provision of users' information and assistance to the authorities in charge of public transport, for example, for the planning and ordering of regional railway services. However the VBB has only a secondary role inside Berlin, where the planning and coordination tasks are handled by the two operators (BVG and S-Bahn) themselves, in direct coordination with the city administration. The VBB is responsible for these tasks mainly outside Berlin, i.e. in the Brandenburg Region.

In spite of having different institutional organisations and powers, the distinct public transport authorities have the following common tasks:

1. The coordination of public transport services.
2. The development of a common fare system for all public transport services and the distribution of its revenues among the operators.
3. The provision of users' information.
4. The creation of a unified image for the complete public transport system and its marketing.

Interestingly, the technical transport authority in Greater London (TfL) is responsible not only for public transport issues, but also for many aspects of the private transport system and non-motorised modes. This is a positive characteristic, as public, private and non-motorised transport are strongly related. Urban planning and land-use definitions are not a direct task of any technical transport office. Nevertheless, the political authority responsible for transport issues is normally also responsible for urban planning, an issue that is also strongly related with transport policies.

Though implying a difficult institutional change that would take several years to be completed, the most suitable solution for the institutional design that is needed for the public transport system and the transport system in general in Santiago is the creation of a regional transport authority. In terms of the transport system, this authority should be responsible for the planning and implementation of both public and private transport policies, strategic plans and projects. It should also be responsible for the non-motorised modes and for urban planning and land-use definitions at the regional level. The different central government agencies that have urban transport responsibilities should transfer them to this regional authority. Responsibilities from other areas different to the transportation could also be transferred to the regional authority, as long as they have a regional scope, but that is

beyond the analyses of this research. The regional government should change its appointment system, in the direction of directly elected head (*intendente*) and representatives. The municipalities would not suffer any drastic institutional change in terms of their transportation responsibilities.

To implement the proposed elected regional transport authority, an agreement of the political forces would be needed in order to make the necessary modifications in the law. This authority would become the second most important political figure in Chile. It cannot be assured that there would be enough political concurrence for the creation of such a strong political post. The creation of a regional transport authority with all the responsibilities defined in the proposal but still appointed by the president should be accepted as a temporary second best solution.

As the organisational problems found in Santiago are also observed in many other developing cities around the world, it could be possible to extend the conclusions and recommendations of this thesis regarding institutional organisation to other metropolitan areas in developing countries. However, the way in which a transport authority is organised is necessarily a response to the own administrative structure of that particular metropolitan area. Therefore, a deep analysis of each particular case is strongly recommended before suggesting a specific institutional design.

### 9.3 Fare Structure and Price

Two main types of public transport tickets could be recognised in the analysis of the three European metropolitan areas:

1. Single tickets that allow one or several trips.
2. Travelcards that allow unlimited trips in their validity period (year/month/week/day).

The concept of a travelcard is completely independent of the technology used for its implementation. It can be a simple piece of paper or a very sophisticated electronic device. On the other hand, an electronic payment device (like the Oyster card in London) can be used both to pay for single tickets and to buy travelcards.

In contrast to the European examples, only single tickets are available in Santiago. Travelcards in London, Berlin and Madrid are intermodal-integrated, i.e. they allow travelling on different public transport modes. Single tickets are only intermodal-integrated in Berlin<sup>20</sup>, where the passenger can change vehicles and modes using the same single ticket, i.e. paying only once for the entire trip. Single tickets in London and Madrid are mainly not integrated, i.e. a new fare has to be paid each time the passenger boards a bus or enters the metro network. The same situation existed in Santiago, but this will change with the introduction of *Transantiago* (in 2007) and its new integrated fare system in which transfers at zero or reduced fares will be possible between buses and metro. London and Madrid could improve the modal-integration of their single tickets (as in Berlin) in order to offer a better and easier-to-use public transport system for infrequent travellers (those for which a travelcard is not convenient).

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<sup>20</sup> The intermodal integration of the fares in Berlin is common to all German cities.

The multi-modal fully integrated **travelcards** found in Berlin, London and Madrid do not exist in Santiago (and are not being planned there as far as the author knows). It was found that travelcards have a very positive impact on public transport patronage. Although they can also have a negative financial impact for the operators, evidence suggests that it is possible to find the appropriate fare levels to make both users and operators better off than under a uniform single-price regime. Therefore, we recommend including travelcards in the fare system of Santiago in the future. However, the positive impacts of travelcards in Santiago should be lower than in other metropolitan areas before, given that some of its benefits were already achieved by the massive introduction of an electronic smartcard.

Given the low price-elasticity of travelcards, it is recommendable to introduce them at a low initial price to achieve a quick market penetration, and later increase their cost to reach the desired long-term price. This strategy also allows to achieve a higher market penetration than if the long-term price was charged immediately.

From a technical viewpoint, the implementation of a travelcard in Santiago would be relatively easy, thanks to the already existing integrated fare system, electronic smartcard and charging network. A difficulty would be the necessary agreement with all public transport operators, but given that there are currently less than 15 relevant operators (in contrast to several thousands before *Transantiago!*) this should not be an important problem. The main problem for the implementation would be the likely unwillingness at the decision-making level, which is to be expected because travelcards are practically unknown there and they fear that they may have an obvious and inevitable negative financial impact (which is not true as already discussed). In addition to the expected positive impact on public transport demand, there are two characteristics of travelcards that could be useful to convince the decision-makers about its implementation: firstly, travelcards can help reducing evasion because users that already bought it can not travel without paying anymore. And secondly, frequent users (mostly belonging to medium and low-income households) would benefit from lower expenditure on public transport.

In the short-term the electronic contactless smartcard that will be used in Santiago allows another simple strategy to reward frequent users: after a passenger has reached some minimum amount of trips in a certain time period (e.g. one month), he could face a reduced fare for the rest of the trips in that period. However, this reduced price scheme does not have all the positive effects of a travelcard, as it does not change the cost perceptions of the users. Therefore, it is not suggested here as a substitute for the travelcard, but only as a temporary easier-to-implement alternative.

In relation with this contactless smartcard, it would be interesting to extend its use (which initially will be restrained to urban buses and metro in Santiago) to other public transport modes not only in Santiago, but also in other cities in Chile and even for interurban trips. A very interesting example of such a wide coverage of a single modern paying device can be found in Denmark, where a national-wide ticketing scheme is being implemented (EMTA, 2005).

Although concentric zones are common to the fare structures of the public transport in London, Berlin and Madrid, a careful analysis of these zones and the fares available yields

that both Berlin and Madrid actually have flat fares inside the main urban areas, with fare zones being relevant only in the surroundings of those areas. Only London has really a zonal fare structure inside the urban area, but with quite a large “smallest fare zone” corresponding to fare zones 1 and 2. So, the “flat fare areas” have surfaces of about 200 km<sup>2</sup> in London, 600 km<sup>2</sup> in Madrid and 890 km<sup>2</sup> in Berlin. From this practical evidence, and given that Santiago has a total surface of about 650 km<sup>2</sup>, it could be suggested for Santiago to maintain a flat fare. The theoretical arguments reviewed also suggest that a flat fare should be preferred inside the urban area. Moreover, given that many low-income households are situated in the periphery of Santiago, there is a social argument for a flat fare. Therefore, in regard to **distance-related fares and zonal fares**, it is recommended for Santiago to maintain the mostly flat fare introduced with *Transantiago*. A completely flat fare as used before *Transantiago* is also a recommendable option inside the urban area. Nevertheless, trips starting or ending outside those boundaries (interurban trips) should face higher prices.

Reduced fares in the off-peak period were partially found in London, Berlin and Santiago. The practice in the selected metropolitan areas as well as the pricing theory suggests that **time-related price differentiations** should exist. The theoretical arguments here are related to the following two facts: firstly that price-elasticity is normally lower (in absolute terms) in peak periods, and secondly that marginal operating costs are lower in off-peak periods. Thus we recommend introducing different fares for peak and off-peak periods in Santiago on buses and metro. As shown in a numerical exercise, it is possible to increase both patronage and revenue through this measure. Also the public transport system of Madrid should include some form of fare differentiation between peak and off-peak periods.

Time-differentiated single fares would be technically simple to implement in Santiago and no serious difficulties seem to exist at the decision-making level. If travelcards were introduced in Santiago, reduced travelcards allowing travel only after the morning-peak should also be implemented (providing a time-differentiated fare), as used in London and Berlin.

A **zone-related price differentiation** yielding higher fares in the centre of Greater London could be recognised, probably as an attempt to have higher charges in the more congested sections of the public transport lines. The theoretical arguments in favour of time-related price differentiation can be extended to the case of higher fares inside city centres<sup>21</sup>. However, for the practical implementation of zone-related fare differentiations fare zones seem to be needed. Given that Santiago does not have fare zones and we do not recommend them, the way in which zone-related price differentiations could be implemented should be carefully analysed before recommending changes in that direction.

When the public transport fares in the four metropolitan areas are compared in terms of nominal prices, i.e. converting all the fares to a common currency using market exchange rates, the **average fare** in Santiago results to be marginally lower than the average fares in Berlin and Madrid, whereas the average fare in London is about twice as high as the fares of the other capital cities. But when the average fare in each case is compared with the disposable income of the population (using the gross domestic product (GDP) per capita as

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<sup>21</sup> It has to be emphasised that these zone-related price differentiations are not related to the trip length, but to the use of specific parts of the network.



a proxy), the public transport of Santiago is more expensive for an average user<sup>22</sup>, followed by London, Madrid and Berlin. This result is explained by the lower GDP per capita in Santiago. The use of a purchasing power parity (PPP) exchange rate does not affect the qualitative results, although it produces quantitative changes in the figures. Interestingly, it is often believed in Santiago that its public transport fares are cheaper than in Europe. This wrong idea comes from a too superficial comparison of only the single fares. But in the European metropolitan areas single tickets are deliberately made more expensive when a travelcard is implemented, in order to create an incentive to prefer the travelcard. For example, more than 60 % of the public transport trips in Madrid are made using a travelcard.

All proposed changes would make the fare structure of the public transport in Santiago much more complicated. Therefore, it would be better to implement them one by one, to make it easier for the users to accustom themselves to the changes. It has to be taken into account that the fare structure of public transport has been historically very simple in Santiago: a flat fare that has to be paid in every vehicle. In general terms, there has to be a trade-off between the efficiency and the simplicity of the fare structure.

#### **9.4 Subsidy for the Operation of the Public Transport**

Unlike Santiago, the public transport systems in the European case study areas receive operational subsidies. This kind of subsidies is fully justified by the economic theory in the case of urban public transport, and also represent a clear policy decision in the direction of giving incentives to the use of public transport.

The main reasons why the public transport in Santiago can operate without subsidy were detected. In comparison to the European capital cities, Santiago

1. presents lower labour (drivers') costs,
2. uses cheaper vehicles (simpler technology) and
3. has a higher occupancy rate of the vehicles (higher crowding levels are accepted).

The first two facts are expected to change in the future, getting closer to the European situations. In fact, as the country gets richer, labour should become more expensive, and the use of more expensive technologies (e.g. low floor buses) can already be observed as a response to general higher income levels and the desire to have better public transport services. In relation with the third fact, although no efforts can be recognised in the last years in order to reduce crowding levels inside the vehicles in Santiago, it is strongly recommended here to do so in the future (e.g. higher frequencies) to improve the quality of the services. It has to be considered that the income growth in Santiago yields higher private motorisation rates and therefore the number of captive public transport users will continue to decline, as has been happening in the last decades. In addition, the fast extension of the metro network may reduce the general occupation factors of the vehicles, as new lines are built in corridors with lower demand.

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<sup>22</sup> This fact partially explains the lower number of public transport trips per inhabitant in Santiago.

Therefore, given these expected future changes and, especially, the economic justification that exists for public transport operational subsidies, it is recommended here to introduce subsidies for the operation of the public transport system in Santiago. However, the political opposition to this measure is expected to be huge, as it is contrary to the accepted practice in Chile of avoiding direct subsidies as much as possible to reduce “unnecessary” fiscal expenditure. A subsidy would be more likely to be accepted if it is financed through other sources. An interesting possibility would be a congestion-charging scheme that could provide a cross-subsidy from car users to public transport. But congestion charging is also politically difficult to implement in Santiago. Penalty charges for enforcement of traffic rules may be a politically easier way of financing public transport (e.g. penalties to cars using bus lanes), although it would need a modification of the law. The way in which subsidies are given has to be carefully designed in order to avoid incorrect incentives for the operators, the users and the authority.

Some numerical examples show the impact of subsidy on demand and revenue, if it were used to reduce the fares. An increase in the demand is expected, implying that the final total income (fare revenue + subsidy) is higher than the original total fare revenue. Because of the demand growth, at least part of this higher income would have to be used to increase the capacity of the system (e.g. more vehicles, higher frequencies). If the subsidy were used to reduce only the off-peak fare, the resulting off-peak demand growth would imply a much lower increase in the operation costs.

Regressive cross-subsidies that have a negative impact on public transport should be eliminated. This is the case if some new infrastructure is paid by public transport users but also benefit car users, a formula that should be avoided in the future. Moreover, the reduced students' fare represents a cross-subsidy from full-fare payers to the students. As the former mainly come from middle and low-income households and the latter (especially at the higher educational levels) mainly belong to middle and high-income families, it can be seen that this is a regressive cross-subsidy. A compensation for the public transport system is necessary. It should be highlighted that this would be a subsidy for the educational system (it would directly benefit students and schoolchildren) to improve its chance to be accepted at the decision-making level.

## 9.5 Future Research

Other topics where the European experiences can be helpful for the development of the public transport systems in Latin-America and particularly in Santiago were detected in this investigation. The following themes are suggested for future research:

1. The development of dynamic information systems and provision of users' information in all its forms (at the stops, inside the vehicles, through internet, etc.).
2. The definition of different hierarchies for bus and tram lines (main and feeder lines as in Santiago, Metrolines as in Berlin) and the structuring of a main complementary metro + bus + tram network.
3. The definition and publication of exact timetables, which would be especially helpful in low demand periods or areas.

4. The design of contracts and incentives for private operators (e.g. quality incentive contracts in the buses in London).

In addition, other policies are necessary to complement public transport in order to accomplish a sustainable urban transport system. Experiences on car parking restrictions, congestion charging, bicycle facilities and pedestrianisations, among others, could be investigated in the future.

## 9.6 Summary of Recommendations

In conclusion we recommend for the improvement of the public transport in the metropolitan area of Santiago:

1. The creation of a regional transport authority responsible for the planning and implementation of both public and private transport policies, strategic plans and projects. It should also be responsible for the non-motorised modes and for urban planning and land-use definitions at the regional level. This authority should be directly elected by the population of the region.
2. The implementation of travelcards allowing unlimited public transport use in their validity period (e.g. a month).
3. The maintenance of a mostly flat fare in the public transport of Santiago. Distance-related fares should be avoided.
4. The differentiation of peak and off-peak single-fares both in buses and metro, and the introduction of reduced travelcards for travelling in off-peak periods.
5. The implementation of operational subsidies for the public transport which can be (partially) financed by a congestion-charging scheme or penalty charges for enforcement of traffic rules.
6. The public transport system should receive a compensation for the reduced students' fare, to avoid the current regressive cross-subsidy financed by full-fare payers.
7. New infrastructure benefiting both public and private transport should not be financed by public transport fares anymore, to avoid the regressive cross-subsidy from public transport passengers to car users.

I hope I will be able to help introducing this measures.

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## Appendix A: Bibliographic Review about Factors that Affect the Demand for Public Transport and their Elasticities

If a normative opinion about the development of public transport has to be given, it is useful to know how its patronage is affected by variables like the fare, the frequency, the lines' density, the income of the population, etc. The estimation of demand-elasticities is a way to help understanding and predicting that kind of interactions.

The demand-elasticity with respect to a variable represents the percentage change of the demand when that variable is modified in 1 %. If  $Y$  is the demand and  $P$  the fare, the demand-elasticity with respect to the fare ( $E_p$ ), also called fare elasticity of the demand, is written as

$$E_p = \frac{\Delta Y / Y}{\Delta P / P} . \quad (\text{A-1})$$

Gschwender (2000) makes a review of public transport demand-elasticities, mainly based on estimations elaborated in the 1970s with data from several developed countries reported in TRRL (1980). An interesting conclusion is that there are only a few variables that have been deeply studied in terms of the demand-elasticities with respect to them. These are two policy variables (fare and vehicle-kilometres) and a socio-economic condition (average income of the population).

Other interesting reviews of public transport demand-elasticities are Litman (2004), Goodwin (1992) and Balcombe et al. (2004), where elasticities of many studies are summarised. The main focus of Litman's review is on demand-elasticities with respect to the fare, while Goodwin examines the differences between short term and long-term elasticities. Balcombe et al. update the TRRL (1980) report re-examining the evidence on factors that affect the public transport demand in the last decades.

In what follows, a review of the evidence on demand-elasticities found in the literature is presented.

### A.1 Demand-elasticity with Respect to the Fare

TRRL (1980) found that the fare elasticity of the demand is in general between -0.1 and -0.6, with a typical average value of -0.3. The negative signs imply that the demand reacts inversely with a fare change, i.e. a fare increase produces a decline in the demand. The average value of -0.3 indicates that when the fare rises in 1 %, the demand decreases in 0.3 %.

Kain and Liu (1999) report a fare elasticity of -0.32, which is practically equal to the average value indicated by TRRL (1980). This elasticity was obtained from cross-section models based on data for the 75 largest transit operators in the USA. Bresson et al. (2003) estimated

a mean fare elasticity close to -0.3, for a panel data of 62 French urban areas between 1987 and 1995. Although not published, an analysis made with data available from modal split models for Santiago de Chile in 2003 yielded a fare elasticity close to -0.3 as well. It is interesting to note the similarity between estimations of the fare elasticity in different parts of the world.

There is evidence that the fare elasticity is higher in the long term than in the short term. So the fare elasticity values indicated in the previous paragraph should be interpreted as short-run elasticities. Litman (2004) indicates that the fare elasticity is usually in the -0.2 to -0.5 range in the short run (first year), and increases to -0.6 to -0.9 over the long run (five to ten years). Bresson et al. (2003) also found that in the long run the elasticity was about twice as high as the short-run elasticity. They estimated a mean long-run fare elasticity of -0.6 for the French cities' sample indicated above. They also found that 99 % of the long-run effect was realised within 6 years. Goodwin (1992) reviewed 50 demand elasticities for bus use, based on studies for the UK and elsewhere, and reported an average short-run fare elasticity of -0.28 and a mean long-run fare elasticity of -0.55. Balcombe et al. (2004) report an average bus fare elasticity around -0.4 in the short run (1 or 2 years), -0.56 in the medium run (5 to 7 years) and -1.0 in the long run (12 to 15 years); an average metro fare elasticity around -0.3 in the short run and -0.6 in the long run, and a local suburban rail fare elasticity around -0.6 in the short run. According to Balcombe et al. and comparing with TRRL (1980), short run elasticities increased in the last decades.

When different fare elasticities are estimated for distinct periods, higher elasticities are typically found for the off-peak and lower values for the peak. This is mainly explained by the different purposes of the trips: more leisure trips in the off-peak and more work trips in the peak. TRRL (1980), Goodwin (1992) and Balcombe et al. (2004) state that off-peak fare elasticities are about twice as high as peak elasticities. Litman (2004) recommends the overall, peak and off-peak elasticities presented in table A-1.

**Table A-1: Fare Elasticities Recommended by Litman (2004)**

Period	Short term	Long term
Overall	-0,2 to -0,5	-0,6 to -0,9
Peak	-0,15 to -0,3	-0,4 to -0,6
Off-Peak	-0,3 to -0,6	-0,8 to -1,0

Source: Litman (2004)

The TRRL (1980) report indicated that the fare elasticity values did not seem to depend on the direction of the change (increase or decrease), while Balcombe et al. (2004) state that there is little convincing evidence of this possible asymmetry. Nevertheless, Hensher and Bullock (1979), Madre (1982) and Litman (2004) point out that the fare elasticity is slightly higher in the case of fare increases. Litman reports values of -0.4 in the short run and -0.7 in the long run when fare rises, and -0.3 in the short run and -0.6 in the long run when fare falls.

Although TRRL (1980) did not find the fare elasticity to be dependent on the initial price level, Bresson et al. (2003), Litman (2004) and Balcombe et al. (2004) found evidence of greater fare elasticities when the initial prices are higher. The magnitude of the fare change may also affect the elasticity value, according to Balcombe et al. (2004). Greater fare increases produce higher values of elasticity than lower increases, especially for long-run elasticities.



Although TRRL (1980) stated that public transport demand elasticities with respect to the fare were higher in smaller cities than in larger cities, the opposite was found in later studies. In fact, Pham and Linsalata (1991) studied 52 transit systems in the U.S.A. during the late 1980s and found short-run fare elasticities of -0.43 in smaller cities (less than one million inhabitants) and -0.36 in large cities. After the study of 89 European cities, Preston (1998) reported fare elasticities of -0.34 for smaller cities (less than 0,5 million inhabitants) and -0.50 for large ones. Preston argues that the lower elasticities in large cities are explained by a greater captivity to public transport because the travel distances are higher than in smaller cities (making walking and bicycle less attractive), and by higher congestion levels and parking problems in large cities which make car travel less attractive. However, Balcombe et al. (2004) show that contradictory results are found in different studies, suggesting that evidence on this issue is not clear enough.

Regarding free fare experiences, TRRL (1980) reports public transport demand increases of between 10 % and 45 %, though only a very small part of the growths correspond to previous car drivers. Bresson et al. (2003) argue that in many instances, free fare programmes have proven quite costly for each new transit user attracted and have rarely lured motorists to transit. Balcombe et al. (2004) state that demand increases due to the introduction of free travel seem to be consistent with normal elasticity values, and that there is no convincing evidence that free travel diverts journeys from cars to public transport.

In qualitative terms, it is typically found that public transport demand is more sensitive to fare changes when more alternatives are available. This is the case for example for trips that can also be made by car, or short trips that can be made walking or by bicycle.

If **travelcards** and single tickets are available, the latter appear to be more price-sensitive than the travelcards. Matas (2004) and García-Ferrer et al. (2002) estimated price elasticities for travelcards in Madrid and both could not find a value statistically different from zero. White (1981) suggests negligible or very low price elasticities for moderate increases in the price of travelcards. Hensher (1998) and Tegner et al. (1998) estimate elasticities of -0.1 and -0.2 respectively for a monthly travelcard. White provides two arguments to explain the lower price elasticity of travelcards in comparison to single fares. Firstly, most travelcard users travel in peak hours. Given that price elasticities are lower in peak hours, a lower elasticity may be expected for this reason alone. Secondly, if only single tickets are available, a fare increase will imply that (a) some passengers cease travel entirely, perhaps purchasing a car, and (b) remaining passengers may reduce the frequency of their public transport trips. But when the price of a travelcard is increased, only the first effect occurs. Remaining passengers do not reduce their trips, because the marginal cost for them is zero. Only if the price increase is high enough to make users return to buying single tickets the second effect will appear. However, some evidence of higher price elasticities for travelcards can also be found in the literature: Dargay and Pekkarinen (1997) obtained an elasticity of -0.5 for bus trips in two regional areas of Finland, but the authors suggest that a possible explanation for this unexpected result can be the small market share of travelcards. Preston (1998) in a literature review reports a wide range of variation, from very inelastic demand (-0.1) to very elastic demand (-2.4). These results should be analysed further. Balcombe et al. (2004) cite other studies which also found travelcards to have lower price-elasticities than single tickets in the UK: York (1995) and McKenzie and Goodwin (1986).

## A.2 Demand-elasticity with Respect to the Vehicle-kilometres

There are much fewer reports in the literature about elasticities of public transport demand with respect to vehicle-kilometres than about fare elasticities. In addition, there are some methodological difficulties in the estimation of veh-km elasticities, as stated by TRRL (1980). On the one hand, when time series data are used, veh-km elasticities tend to be overestimated, because it is not possible to distinguish between cause and effect. Therefore, part of the measured elasticities may represent the response in the number of veh-km to changes in the patronage. On the other hand, elasticities calculated with cross-section data may also be overestimated, because areas with higher demands normally have better services, i.e. more veh-km. Thus, TRRL (1980) suggests that the more reliable estimations of vehicle-kilometre elasticities are those made with “before and after” data.

TRRL (1980) reports veh-km demand elasticities from time series in the 0.2 to 1.2 range, with an average of 0.7. Very close values were found by De Rus (1990) from time series for Spanish cities. Using cross-section data, TRRL (1980) found veh-km elasticities in the 0.6 to 1.4 range, with a mean of 0.7. Kain and Liu (1999) report a veh-km elasticity of 0.71, obtained from a cross section of cities in the USA. Nevertheless, these elasticities may be overestimated, as explained above.

In the more reliable “before and after” studies reported in TRRL (1980), veh-km elasticities between 0.2 and 0.5 are found. Bresson et al. (2003) estimated veh-km elasticities for the long and short run, using a panel data of French cities. They found a short-run veh-km elasticity of 0.29 and a long-run elasticity of 0.57. All these elasticities are, in absolute value, very close to the fare elasticities.

Reviewing some 25 studies, Balcombe et al. (2004) report an average veh-km elasticity of 0.4 in the short run and 0.7 in the long run for bus services. For rail services the elasticity seems to be higher, but there is much fewer evidence in this case.

Preston (1998) obtained higher veh-km elasticities in large cities than in small ones (0.49 and 0.33 respectively). This seems to be because of greater modal competition in bigger cities. The same qualitative result is reported in Balcombe et al. (2004).

An increase in the number of veh-km may be explained by different service expansions as higher frequencies, higher lines' density or new service areas. Does the value of the elasticity depend on the type of service expansion?

Higher frequencies imply lower waiting times, and higher density of lines yield lower access or walking times. TRRL (1980) reports that the public transport demand elasticity with respect to the **waiting time** is in the -0.1 to -0.6 range, with an average of -0.4. This elasticity tends to be higher (in absolute value) when the initial frequencies are lower. Balcombe et al. (2004) reports a higher average waiting time elasticity of -0.64. They state that values for off-peak journeys and journeys to non-central destinations tend to be higher.

Regarding the elasticity with respect to the **walking time**, the range reported by TRRL (1980) is between -0.1 and -0.5, i.e. similar to the waiting time elasticity. When new service

areas are added, the veh-km elasticity seems to be higher, in the 0.6 to 1.0 range, as reported by Litman (2004).

Although the **reliability** or punctuality of the services seems to be very important, there is little information about it. TRRL (1980) reports that the impact in the demand of a veh-km reduction is 33 % higher if this reduction is not planned (unreliability). In a stated preferences experiment in Netherlands, Rietveld et al. (2001) found that an “uncertainty minute” in the arrival time was valued 2.4 times higher than a certain in-vehicle minute. They concluded that the respondents showed a substantial dislike for unreliable transport services. Hensher and Prioni (2002) found that bus reliability (in terms of minutes late) is valued at around 1.82 times in-vehicle time (Balcombe et al., 2004). Balcombe et al. state that punctuality, reliability and dependability are rated by public transport users as a very important feature, affecting both their perceptions and levels of use for different modes.

Again, as was the case for the fare elasticity, transport demand is more sensitive to veh-km changes when more alternatives are available (for instance, short trips that can be made by bicycle or walking, and when the trip can be made by car).

### **A.3 Demand-elasticity with Respect to the Income of the Population**

The income level impacts on the public transport demand in two different ways. On the one hand, higher incomes imply a greater mobility, i.e. more trips are made in general when more income is available. On the other hand, higher income has an impact on modal split, through a greater motorisation rate and therefore a bigger proportion of the trips made by car. As the two effects have opposite signs, the final impact of income in the public transport demand will depend on which of both effects is greater.

The studies reviewed in TRRL (1980) showed negative net impacts of income in public transport demand. Income elasticities in the -0.16 to -0.8 range were found for some developed cities. Balcombe et al. (2004) reviews a few studies with data from the UK, finding values for the income elasticity of public transport demand between -0.5 and -1.0 in the long run and somewhat smaller in the short run. Bresson et al. (2003) found also negative income elasticities for a panel data of French cities, but the values were close to zero. They estimated a mean income elasticity close to -0.05 in the short run, and an average long-run income elasticity of -0.08.

Both TRRL (1980) and Bresson et al. (2003) indicate that the negative impact of income in public transport demand will be higher when motorisation rates are lower. As car ownership approaches saturation, the income elasticity can be expected to become less negative (Balcombe et al., 2004) or even positive (Bresson et al., 2003).

A different result is found by Matas (2004) for the case of Madrid. Estimating demand equations using a double log specification and time series data between 1979 and 2001 for the city of Madrid, a positive short-run income elasticity equal to 0.15 is found for buses and metro. Basing on a study by Asensio et al. (2003), Matas argues that in small cities the relative quality of public transport tends to be worse, and therefore car ownership levels are

more income elastic and public transport services have characteristics of inferior goods, i.e. the income elasticities are negative. On the contrary, in larger cities like Madrid the quality of public transport is usually better, and public transport is seen as an alternative for the car, so that its use is less sensitive to changes in income (Matas, 2004 pp205-206). It has to be taken into account, that Madrid is considered a “successful example” of improving public transport service and increasing ridership, after several measures started in 1986. Thus, it can be argued that in a big city with high-quality public transport, income elasticities can be expected to be positive.

Previously, FitzRoy and Smith (1998) estimated income elasticities of the public transport demand between 0.4 and 0.8 for the German city of Freiburg (200,000 inhabitants) using time series data between 1969 and 1995. Again, the city of Freiburg is considered a model of success in increasing public transport demand, which more than doubled between 1983 and 1995, thanks to an integrated policy of improving public transport, restricting car use and an integrated transport and urban planning (FitzRoy and Smith, 1998). Being not a very big city but a medium sized city, it could be argued that the size of the city is not really a key factor, so that income elasticities should be expected to be positive in medium sized or large cities with high quality public transport.

#### **A.4 Other Factors that Affect the Demand for Public Transport**

There are other variables for which some evidences of their impact on the public transport demand exist.

Hass-Klau and Crampton (2002) examine 24 cities with light rail systems in Europe, North America and Australia. They analyse how successful the light rail systems of these cities have been, using the number of passengers per light rail track-km and passenger-km per light rail track-km as general measures of success. In order to explain the differences in the success of the diverse cities, they estimate multiple regression success models, using the following characteristics as explanatory variables:

- Average speed of light rail service,
- newness, i.e. percentage of light rail vehicles that are less than 5 years old,
- peak service headway,
- network density (total light rail track-km per urban population),
- percentage of light rail passengers using a travel card,
- monthly light rail fare relative to the country's GDP/capita,
- suburban rail stations (competing mode) relative to urban population,
- number of car parking spaces in the city centre (competing mode) relative to city centre area,
- population density in 300 m light rail corridor either side of lines per km of track,
- pedestrian street length per city population,
- number of park and ride spaces per km of light rail track.

Other explanatory variables were identified but not included in the statistical analyses, mainly because of data difficulties. These variables were related with hours of light rail service or headways, the price of city centre parking spaces and the average distance between stops.

Although the sample was relative small in relation with the high number of explanatory variables analysed, it was possible to conclude that some variables were especially significant in explaining the success of the light rail systems. The most important variables were the percentage of light rail passengers using a travel card, the pedestrian street length per city population, the population density in 300 m light rail corridor either side of lines per km of track and the monthly light rail fare relative to the country's GDP/capita.

Instead of using patronage indicators as the dependent variable in the regression analyses, Hass-Klau and Crampton (2002) used a performance index, because it was empirically seen that it was easier to obtain a good statistical fit this way. Therefore, it is not possible to obtain elasticities from these regressions.

Kain and Liu (1999) report elasticities for two socio-economic variables, which they found affect importantly the demand for public transport, namely the **metropolitan area employment** and the **central city population**. From a cross section of cities in the USA, they obtained an elasticity of the public transport demand with respect to the metropolitan area employment of 0.25, and an elasticity with respect to the central city population of 0.61. Regarding the location of the employment, they point out that CBD workers are normally much more likely to use transit than people who work in other parts of the city.

Bresson et al. (2003) indicate that riders are approximately twice as sensitive to changes in **travel times** (in-vehicle time) as they are to variations in fares. Nevertheless, TRRL (1980) reports lower elasticities with respect to the travel time in the -0.3 to -0.5 range. Balcombe et al. (2004) report slightly higher values for bus services in the range -0.4 to -0.6, and for urban or regional rail in the range -0.4 to -0.9. Moreover, according to TRRL a **transfer** is perceived as 3 or 4 extra waiting minutes (in addition to the actual walking and waiting time in the transfer). Balcombe et al. (2004) report that a transfer is perceived as an equivalent of 21 minutes in-vehicle time in the case of bus trips, and 37 minutes in-vehicle time in the case of rail journeys (in both cases including additional walking and waiting time as well as the inconvenience of interchange *per se*). They state that there is considerable variation between journey purposes and from place to place, and that interchange penalties may be much smaller in urban environments with high-frequency public transport services. Although there is little quantitative evidence on the negative impact of interchanges in public transport demand, in several studies the importance of this effect is emphasised (Ben-Akiva and Morikawa, 2002; Hensher, 1999; Cullinane, 2003).

The **operating cost of the car** also affects the demand for public transport, as they are alternative modes. Goodwin (1992) summarises the results of 3 studies on cross-elasticity of public transport demand with respect to petrol prices, finding a range between 0.08 and 0.8 with an average value of 0.34. Litman (2004) recommends elasticities with respect to the auto operating cost in the 0.03 to 0.1 range in the short run, and between 0.15 and 0.3 in the long run.

Van Exel and Rietveld (2001) analyse the effect of **strikes** in the public transport demand. They review 13 studies of public transport strikes in different developed cities, finding that the

magnitude of the effects of a strike varies strongly according to the type and circumstances of it. They report that in the long term a strike can cause a 0.3 % to 2.5 % reduction in public transport use, because the strike impacts upon the perceived reliability of public transport services. In addition, the transit user is forced to look for an alternative, and he may find a better one.

Other variables that can increase transit use, particularly in areas where service is less frequent, are **schedule information, easy-to-remember departure times and more convenient transfers** (Litman, 2004). The availability of **road space for the car use** can also affect the demand for public transport, as they are competitive modes (Gschwender, 2000). In fact, road capacity expansions will induce new car traffic and therefore reduce transit use. Furthermore, car capacity reductions can suppress traffic and increase transit use (Cairns et al., 1998).

In a survey in Hong Kong, Cullinane (2003) found that the public transport attributes that were declared to be the most important were frequency, reliability, fares, speed and comfort. Although the reliability was in average the second most important attribute, considering only the attribute declared as most important, reliability came out top. So there is an important group for which the reliability is in fact the principal attribute. This implies that the preferences of the people could be better understood if the analysis was made separating the population in different groups.

## A.5 Conclusions

Elasticities are place-specific. Therefore, local estimations should be used when possible. Nevertheless, the revision presented in this chapter allows drawing some conclusions about elasticities values that can be useful if no better information is available. Furthermore, other variables that affect public transport use, for which quantitative information was difficult to find, were discussed.

In general, elasticities are higher in the long term than in the short term. Moreover, they are higher in the peak period, when more work trips are made, than in the off-peak period, when a higher proportion of leisure trips are made.

The variable for which more quantitative information is available is the fare elasticity. Its value is typically in the -0.2 to -0.6 range in the short run, with an average of -0.3 to -0.4. In the long run the fare elasticities are twice as high as in the short run. Fare elasticities increased in the last decades. Travelcards elasticities are lower (in absolute value) than single ticket elasticities.

As fare elasticities are, in absolute value, less than 1, revenue rising by fare increases is an effective policy, but demand increases only by fare reductions is rather limited. But in the longer run the effectiveness of the first policy is reduced, and of the second is increased (Goodwin, 1992). Moreover, the newer estimations reported in Balcombe et al. (2004) show that long-term fare elasticities can exceed -1. While the immediate effect of a fare rise might be a temporary increase in revenue, the long-term effect is likely to be a decrease. They

state that attempts to counter falling revenue with fare increases alone will eventually fail, and that reversal of negative trends in public transport patronage requires service improvements and possibly fare reductions.

Time series and cross-section studies yield veh-km elasticities that are higher than the fare elasticities (in absolute values). This would imply that it would be a good policy to increase fares and veh-km, in order to increase the patronage. Nevertheless, those veh-km elasticities seem to be overestimated. In more reliable studies the veh-km elasticities are similar to the fare elasticities (in absolute values). So it is not clear if a better policy would be to reduce veh-km and fares. This has to be analysed deeper in each specific case.

The elasticities of public transport demand with respect to the income are mostly negative, which implies that public transport is an inferior good, i.e. it is less consumed when economic conditions improve. However, as car ownership reaches saturation, additional income growth could have a positive effect on public transport demand. On the other hand, in cities with high quality public transport income elasticities can be expected to be positive.

Other policy variables that seem to be especially important for the public transport patronage are the use of travelcards, the length of pedestrian streets, the frequency and conditions of transfers and the reliability of the services. Socio-economic variables that are also important are the population density, the level of employment and the central city population.

It is important to note that not all the public transport demand growth resulting from fare decreases, service improvements, etc. represents reductions in car use. In fact, part of this new ridership may substitute for walking, cycling or rideshare trips, or even come from increases in personal mobility. Litman (2004) indicates that only a quarter to a half of increased transit ridership represents a reduction in automobile use, though this figure can vary considerably between different areas. In order to predict the impact that changes in transit fares can produce in car use, Litman recommends cross elasticities of automobile travel with respect to transit fares between 0.03 and 0.1 in the short run, and between 0.15 and 0.3 in the long run.

The impact of attribute changes in public transport demand are normally analysed at an aggregate level. Nevertheless, different population groups can have distinct reactions to the changes. For instance, Iida et al. (1992) conducted a laboratory experiment to analyse route choice behaviour and identified individual variation in how the decisions were made: some individuals are less likely to change route, while others tend to change very frequently. Therefore, in order to better understand the preferences of the people, analyses considering different population groups should be made.

Integrated policies of improving public transport services, together with complementary measures of urban planning and restricting car use, seem to be the most successful experiences. Cases like Freiburg in Germany, where patronage more than doubled between 1983 and 1995 are mainly explained by several improvements in the public transport service (network expansion, frequency increase, introduction of travelcards with interpersonal transferability and regional validity, introduction of park-and-ride facilities) and also traffic calming and parking restrictions, pedestrianisation in the city centre, a dense network of bicycle lanes and a simultaneous transport and urban planning (FitzRoy and Smith, 1998).