

Social and environmental benefits of the Lisbon Metro system

Ana Cerdeira, Marta Laborinho and Ana Lobato

1- Introduction

The metro is a safe urban transport mode, with a high capacity and frequency, not subject to interference from other transport modes and allowing for public transit separated from the road network, although limited to its own network coverage.

It was considered pertinent to study how the existence and operation of a metro system has, over the decades, resulted in both social and environmental benefits for the city of Lisbon and its Metropolitan Area.

This paper therefore seeks to compare the existing reality in 2010 to an almost unthinkable scenario: **“How would life be in Lisbon without a metro network?”**

2- The Lisbon Metro – from 1948 to the present day

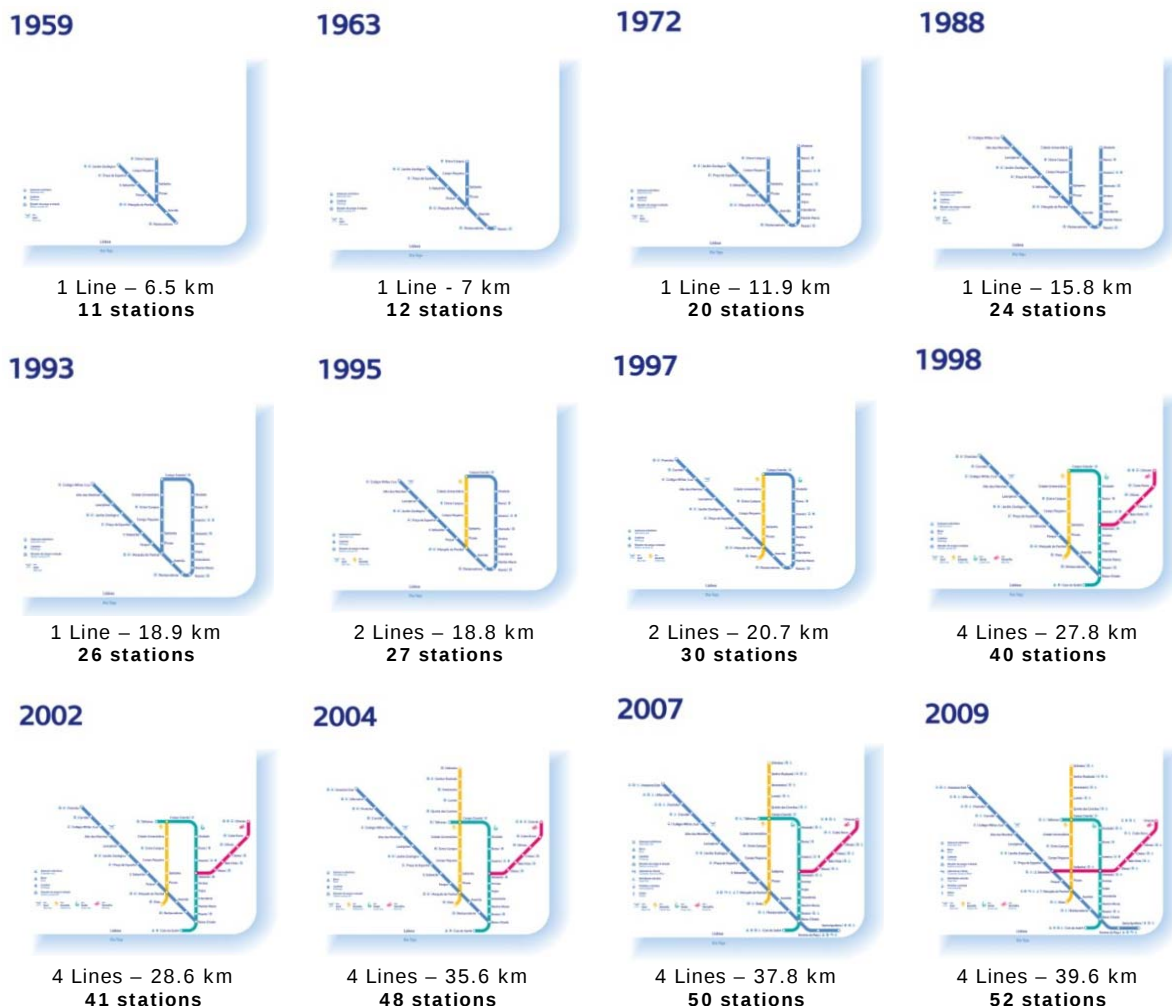
2.1 Company and network evolution

Since 1948, the year of its establishment as “Metropolitano de Lisboa S.A.R.L.”, the Lisbon Metro undertook the mission to become a highly structuring mode of transport in Lisbon, positively influencing the evolution of the city and its standards of quality of life.

In 1955, construction work began in the infrastructure and, in 1959, a small metro network was launched, consisting of 1 Line, with 6.5 km and 11 stations.

By that time, the Lisbon Metro was the 14th European metro and the 25th worldwide. Since 1959 to the present days, the Lisbon Metro network has had an enormous evolution, as can be seen in the following scheme. Today, the network has 39.6 km, 52 stations and 4 independent and integrated Lines.

Scheme - Network evolution



The way the metro network evolved in Lisbon over the years may be subject to different assessments, either positive or negative. This expansion may be looked upon as being disconnected from the urban sprawl and land use planning in the city of Lisbon. However, the purpose of this study is not to evaluate the potential expansion options for the Lisbon metro network and only considers the existing network as a baseline scenario (hereinafter referred to as BASE SCENARIO).

However today, 52 years after the launching of its operation, it is undeniable the role and importance that the metro system plays in the mobility and traffic logic of the city of Lisbon, as well as on structuring and reorganizing the urban space. It is also unquestionable that such a transport mode is an extremely positive factor in the quality of life in any city.

2.2 Company in 2010

Recent Overview

The **MAIN PURPOSE** of the Lisbon Metro consists of operating a regular public passenger transport service, *in situ proprio*, mainly underground, in the city of Lisbon and peripheral areas, as well as the execution of all activities related to the maintenance, modernization and expansion of its network.

Its **MISSION** is to provide a public passenger transport service, in metro mode, that is customer-oriented and promotes sustainable mobility. The prospective **VISION** of the Lisbon Metro makes it the guarantor of the social mobility in urban areas, according to quality standards and economic, social and environmental effectiveness.

The **MAIN HIGHLIGHTS** of the Lisbon Metro at the end of 2010 are as follows:

- 3.4% increase in demand, reaching around 183 million passengers carried;
- 9.4% increase in supply;
- A network with 52 stations and approximately 40 km;
- An expansion project that will add to the current network 4.5 km and 4 new stations (3 new stations by 2012), 2 of which are important multimodal interfaces (the first in Reboleira, connecting with the Sintra railway line and public road transport operators, and the second one connecting to the Lisbon International Airport);

Table 1 - Network expansion								
Current network			In progress			Future network		
Lines	No. of stations	km of network	Extensions	No. of stations	km of network	Opening date	No. of stations	km of network
Yellow	13	11.0	-	-	-	-	13	11.0
Blue	17	12.9	Amadora Este / Reboleira	1	0.9	2014	18	13.8
Green	13	8.9	-	-	-	-	13	8.9
Red	9	6.8	Oriente / Aeroporto	3	3.6	2012	12	10.4
Current Network	52	39.6		4	4.5	Future Network	56	44.1

- Ranked in 1st place in the National Customer Satisfaction Index (ECSI) for the 5th consecutive year, thus being elected as the best public transport in the Lisbon Metropolitan Area.

In brief, the Lisbon Metro can be characterized as follows:

Table 2 - Public passenger transport service in metro in 2010	
Passenger journeys	182.8 x 10 ⁶
Average trip per passenger	4.7 km
Passenger x km	866.3 x 10 ⁶
No. of stations	52
Network extension	39.6 km
No. of lines	4
No. of depots	2
Rolling stock fleet	338
Staff on 31/12/2010	1,672

The customer

The "Market Study of the Metro Customer" was developed in 2010 by "VSA Inovação", in order to obtain more information on the habits and needs of the Lisbon Metro's customers. According to this study the Lisbon Metro's **customer profile** is as follows:

- mostly female, aged between 15 and 34 and single;
- owns a driving license and private vehicle;
- self-employed, with secondary level education qualification and a monthly income between €500 and €1 500;
- 44% live in Lisbon and 20% come from Amadora and Odivelas (suburban areas near Lisbon).

Its **usage profile** is characterized as follows:

- frequent user, making at least 11 trips per week;
- uses mostly terminus stations or interfaces with other transport modes;
- mostly walks to the metro (58%) and from the metro to the final destination (72%);
- travels mostly in a single line (60%), but also transfers between lines (40%);
- the second most used mode of transport is the bus;
- the total travel time is, on average, 38 minutes per trip;
- travels to work / school (80%), uses passes (84%) instead of tickets and is a metro customer for over 2 years (80%);
- the customers and usage profiles are similar for the 4 Lines;
- in the absence of the metro mode, the bus is the main alternative (76%), followed by the car (15%).

For the Lisbon Metro's customers the **most important aspects** are the travel and dwelling times, making these the most important factors when choosing the metro as the best transport mode. Fuel and parking prices are not very relevant to this decision.

3- Scenario comparison

3.1 Methods

In order to quantify the social and environmental benefits, considering the city of Lisbon both with (BASE SCENARIO) and without (ALTERNATIVE SCENARIO) the metro network infrastructure, 2010 was defined as the reference year. Whenever data for 2010 was not available, the most recent one was collected¹. Worth noting is the fact that the slightly outdated base information used in this study constitutes a vulnerability, which influenced the obtained results.

The following transport modes were considered in the calculations: on foot/bicycle, private transport/car, public transport, including bus (Carris), metro (ML), train (CP and Fertagus) and tram (Carris).

The mobility in Lisbon was characterized for each one of the scenarios, calculating the corresponding modal split² and passengers x km by transport mode³. This last indicator takes into account the weight of each transport mode in relation to the distance traveled in that mode.

Based on the abovementioned methodology, the social and environmental benefits of the analysed scenarios were quantified. The variables — travel time per trip, energy consumption and greenhouse gas (GHG) emissions — were adequately estimated.

3.2 Life in Lisbon with a metro network (BASE SCENARIO)

For the BASE SCENARIO, considering Lisbon Metro in 2010, the following results were obtained:

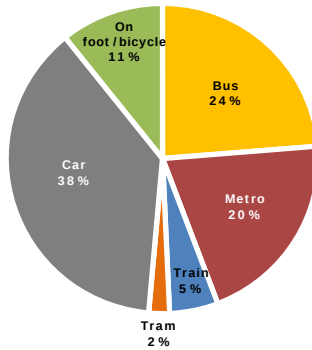
¹ Recent data from "Resultados Definitivos dos Censos 2011" will be available by the 4th quarter of 2012

² Percentage of passengers by transport mode.

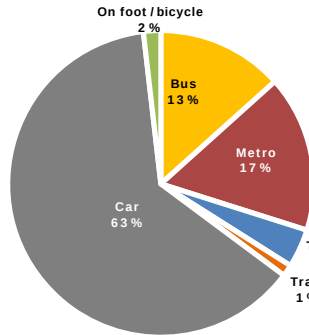
³ Passengers x km = $\sum (\text{passengers per mode} \times \text{average journey distance per mode}) / \text{total number of passengers in all modes}$

Mobility in Lisbon

Graphic 1 - Modal split

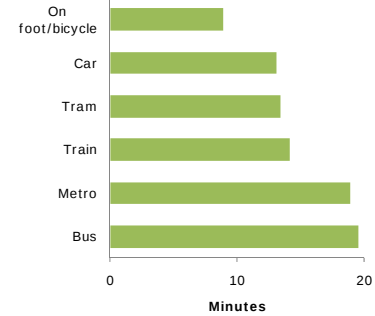


Graphic 2 - Passengers x km



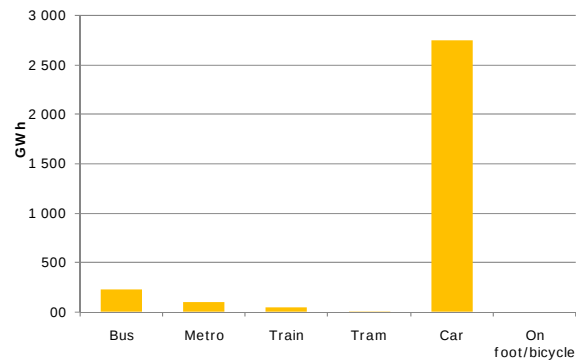
Travel time per trip

Graphic 3 - Travel time per trip

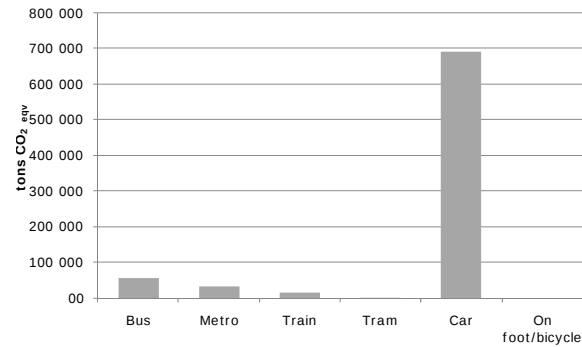


Energy consumption and GHG emissions

Graphic 4 - Annual energy consumption



Graphic 5 - Annual GHG emissions

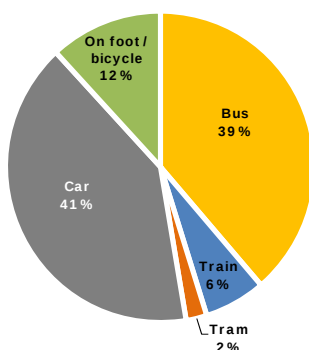


3.3 Life in Lisbon without a metro network (ALTERNATIVE SCENARIO)

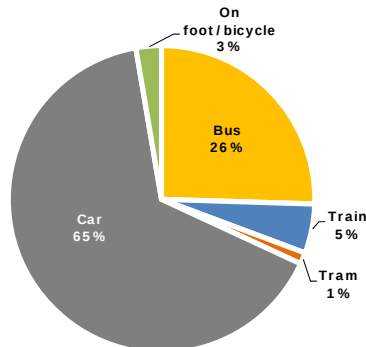
For the ALTERNATIVE SCENARIO, which considers the absence of a metro network in Lisbon in 2010, the obtained results are shown below:

Mobility in Lisbon

Graphic 6 - Modal split

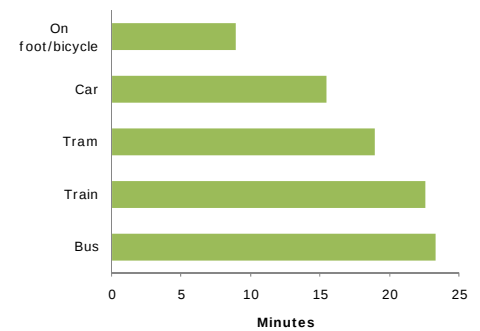


Graphic 7 - Passengers x km



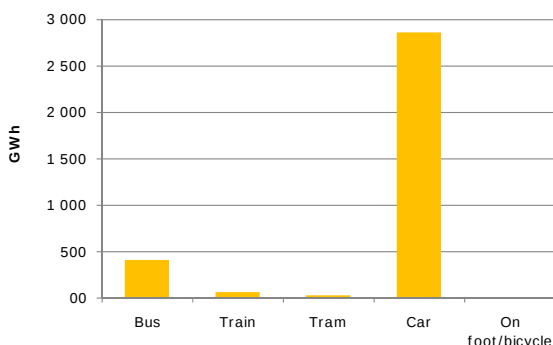
Travel time per trip

Graphic 8 - Travel time per trip

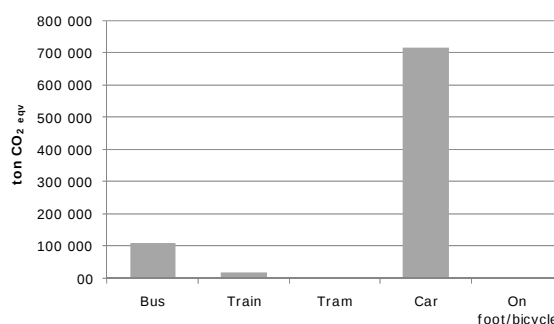


Energy consumption and GHG emissions

Graphic 9 - Annual energy consumption



Graphic 10 - Annual GHG emissions



3.4 Comparison

In the following table, a comparison is made between the results obtained for the BASE and the ALTERNATIVE SCENARIOS.

Table 3 - Comparison between the results for the two considered scenarios

	Base scenario	Alternative scenario	Differential
Travel time per trip (minutes)	16.1	20.3	4.2
Energy consumption per year (GWh)	3,122	3,339	217
GHG emissions per year (tons CO ₂ eqv)	794,986	845,218	50,233

Based on the comparison of results, it is now possible to answer the question: “**How would life be in Lisbon without a metro network?**” in the following way:

- In terms of **modal split**, there would be a slight increase in the use of private transport (+3%); the increase in bus use would predictably be substantially higher (+15%);
- As for **passengers x km**, there would be a similar increase in the same modes: 2% for private transport and 13% for the bus;
- Concerning the **travel time per trip**, initially each trip would have an average additional time of approximately 4 min 13 sec, regardless of the selected mode of transport. In such circumstances, each passenger would have to spend an extra 49 hours per year to undertake the same journeys within the city boundaries, which corresponds to approximately 6.5 days of work;
- The resulting additional yearly **energy consumption** would be of 217 GWh;
- Finally, the additional yearly amount of **GHG emissions** would be of 50,233 tons of CO₂eqv, a consequence of the increase in energy consumption due to the mobility needs of passengers.

4- Conclusions and final considerations

The work carried out clearly shows that the Lisbon metro system makes a strong contribution to the quality of life of those who live or work there.

With the calculations and subsequent comparison made between the BASE SCENARIO, in 2010, and the ALTERNATIVE SCENARIO, "Life in Lisbon without a metro network", it was possible to quantify the social and environmental benefits associated with this transport mode.

Time is a factor of increasing value and the time spent travelling, especially in a city like Lisbon, has some significance every day. With regard to travel time per trip, it was possible to quantify great benefits in travel time savings associated with the use of the metro.

On the other hand, the Lisbon Metro is clearly an environmentally friendly transport where energy consumption is concerned, with a very good performance not only in relation to other modes, but also when compared to metro networks in other cities (essentially due to its rolling stock, which provides traction

energy recovery). These benefits, with great economic gains associated, were clearly demonstrated in the work carried out.

Although the Lisbon metro belongs to the transport sector - one of the largest contributors to the global GHG emissions - the benefits of this mode in terms of emissions stand out when compared with the other transport modes. This contributes to a less polluted city and, consequently, to achieve the Kyoto Protocol targets for GHG emissions reduction.

To its inhabitants, it is unthinkable to imagine Lisbon without the METRO!

5- Acknowledgments

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