

# BIKE-SHARING SCHEMES AND SUSTAINABLE URBAN MOBILITY. AN ANALYSIS IN THE CITY OF PALMA (MALLORCA, BALEARIC ISLANDS)

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## I. INTRODUCTION

### I.1. General framework. Public bike-sharing schemes as a means of promoting sustainable mobility in cities

Public bike-sharing schemes have been introduced to many cities in recent years, where they have seen a growth in popularity and become new non-motorized forms of mobility integrated in the public transport system (PARKES *et al*, 2013). As well as being seen as a useful way of encouraging bike travel, the safety and convenience of such systems and the benefits that bicycles offer in regular travel all make a positive impact (HEINEN, VAN WEE y MAAT, 2010; GOODMAN *et al*, 2014).

In early 2014, there were estimated to be some five hundred third-generation public bike-sharing schemes throughout the world (MEDDIN and DE MAIO, 2014), with a network of docking stations where users pick up a bike in one place and return it to another at the end of their trip. The literature on these schemes generally focuses on their analysis and how they work. De Maio explores the history, evolution and characteristics of third-generation schemes (DE MAIO, 2009). Similarly, Parkes *et al* (2013) offer an analysis of the dissemination of these schemes, particularly in North America and Europe. Dell'Olio, Ibeas and Moura (2011) and Chemla, Meunier and Wolfler Calvo (2013) look in detail at more technical aspects. Aldred (2013) and Fishman, Washington and Haworth (2012) offer an analysis of user profiles and their main characteristics. Castro (2011) analyses these schemes' contribu-

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<sup>1</sup> Sadly, lecturer M. Rosa Martínez passed away on January 15th 2015. May she rest in peace.

tion to sustainable mobility in Europe. A modal shift toward pedestrian and bicycle transport also plays a very important role in public health policies (ROJAS-RUEDA *et al.*, 2011). In Spain, various studies can be highlighted, like that of Castillo-Manzano and Sánchez-Braza in Seville (2013). As for GIS-based spatial analyses, one relevant contribution is that of García-Palomares, Gutiérrez and Latorre (2012), using the city of Madrid.

This paper looks specifically at the spatial coverage and impact of the introduction of a public bike-sharing scheme, BiciPalma, in the city of Palma on transport as a whole, within the framework of sustainable mobility. By including sustainability in the geography of transport systems (MIRALLES-GUASCH y CEBOLLADA, 2009) and, more particularly, sustainable mobility planning (BANISTER, 2007), the aim is to bring about a change in travel practices in order to reduce the overall environmental impacts of transport and to improve citizens' quality of life and access to new means of mobility, giving them a central role in planning.

Europe's sustainable mobility strategy, based on a modal shift, is outlined in several different documents, one of the most relevant being the White Paper On Transport (2011). One key objective of sustainable urban mobility plans, both in Europe and in Spain (HERCE, 2009), is to boost public transport and non-motorized forms of travel. Public bike-sharing schemes fit in with sustainable urban mobility plans by encouraging bicycle travel, particularly in cities where this is not a traditional form of transport.

In our analysis, we aim to assess the coverage of Palma's public bike-sharing scheme by examining the evolution of the modal distribution of travel, the network's spatial scope, cycle traffic generated by the new scheme, and the characteristics of its users. For this purpose, three sources of data were used: two mobility surveys conducted in 2009 and 2013, data on the use of public bicycles compiled by Palma City Council, and, finally, the results of a 2013 survey given to users.

## 1.2. Target area of the study

Palma is a city with a population of 398,000 inhabitants (2013), half the population of Mallorca (Balearic Islands). It is the island's capital city and the main centre of its transport system and rail, road and underground networks.

Since the year 2000, Palma City Council has conducted various different studies and carried out initiatives in the field of sustainable urban mobility. In 2011, BiciPalma was created, a public bike-sharing scheme with 28 docking stations, 485 locking points and 300 bicycles. It is slightly smaller in size than schemes in other Spanish or European cities, both in terms of the number of bikes per thousand inhabitants and the number of docking stations. Comparatively, Seville, Barcelona or Valencia's schemes are treble the size of Palma's bike scheme.

## II. METHOD

The mobility surveys conducted in 2009 (Mallorca Transport Consortium - Consorcio de Transportes de Mallorca) and 2013 (Palma City Council) provide information on the modal distribution of transport and number of trips made on a typical working day. The first survey

was conducted within the framework of a global mobility study for the whole of the island of Mallorca, using a very large sample and conducting 5,000 interviews by phone in the municipality of Palma alone, stratified according to the gender and age of the interviewees. In the case of the 2013 survey, 600 people were interviewed. In both cases, the interviewees were over the age of 16 and specific questionnaires were used in which they were asked about the last journey they had made.

For the spatial characterization of the BiciPalma bike-sharing scheme, data on the bikes picked up from and returned to each docking station during a period of a week in 2012 and 2013 was gathered. Using GIS tools, each of the stations was geolocated and, using the digital road networks created as part of the CartoCiudad project, Palma's road network was reproduced and the 300-metre scope of influence of each station was calculated. The population within the scope of influence of each station was estimated, using data broken down into urban blocks, supplied by Palma City Council for 2013. This was a similar procedure to that used to estimate the coverage of the network of cycle lanes.

To gather information about the profiles and characteristics of the scheme's users, data supplied by the managing body of the bike-sharing scheme was used. This was complemented by an on-line survey conducted between November 12th and 26th 2013, sent by email to all BiciPalma's users, who were quantified as amounting to 2,224 people at the time. From the survey, a total of 716 valid answers was obtained (32% of the universe) and user profiles could be built up by gender, age, and socioeconomic level, in addition to details of the last trip each user had made and a general opinion of how the scheme worked.

Lastly, monthly counts of cyclists by Palma City Council were used, recorded by video camera at two specific points along cycle lanes in the city centre. One working day per month, a count was made of all the bicycles passing these two points between 8 a.m. and 8 p.m.

### **III. RESULTS**

#### **III.1. Spatial coverage and uses of the BiciPalma bike-sharing scheme**

When the resident population living within 300 metres of a BiciPalma docking station was taken, the BiciPalma scheme was estimated to have a coverage of 98,896 inhabitants (2013); one fourth of the city's population. In contrast, the geographic coverage (the urban area covered by the system) was observed to be very low, covering less than 10% of the municipality's urban area. In comparison, the cycle lanes' coverage was observed to be much greater, since it served 187,352 citizens living within a distance of 300 metres of the network, almost half Palma's residents.

From the data that was analysed for the working week from Monday May 6th to Friday 10th 2013, a total of 3,058 trips were made. This represents a daily average of 611 trips for the whole bike-sharing scheme, with an average of 21 daily trips per docking station, and 0.3 daily trips per user. The peak hours of bicycle traffic from the BiciPalma bike-sharing scheme were first thing in the morning from 7 a.m. to 9 a.m. and first thing in the afternoon, from 1 p.m. to 3 p.m., with two troughs between 10 a.m. and midday and between 4 p.m. and 6 p.m. First thing in the morning, there were flows from the periphery to the centre, and, from 1 p.m., this was reversed.

### III.2. User characteristics

From the profiles of BiciPalma users, built up using the survey conducted in November 2013, a greater male presence could be observed (60% men versus 40% women). The scheme's users were mainly in the 35 to 55 (54%) or 25 to 34 year old age bracket (26%), and the majority had university studies (77%). Most of the users (61%) were salaried workers and only 15% were self-employed workers or employers. Only 8% were unemployed and just 3% were pensioners or retired individuals.

As for use of the BiciPalma bike-sharing scheme, the survey showed that only 20% of its users used the scheme on a daily basis, 34% used it two or three times a week and 12% only used it once a week. The main reasons for its use were to get to work (31%), to carry out personal formalities (30%) and for leisure purposes (22%). Reasons associated with its convenience were the most common (56%), accounting for a higher percentage of replies than purely environmental motivations or an awareness of the importance of sustainable mobility (19%). Not having a car accounted for only 5% of the answers. When the users' place of residence was analysed, 95% of the interviewees were found to be residents living in the same municipality. The remaining 5% mainly lived in nearby municipalities or in Palma's metropolitan area, in places like Marratxí, Calvià, Consell and Esporles. 87% of the users walked to the BiciPalma docking stations, while the rest travelled by private vehicle (7.6%), chiefly by car or on public transport (5.7%). The most highly rated aspects of the scheme were mechanical ones (associated with the docking stations or bikes) or else they concerned how the scheme worked in general. Factors like the location of the docking stations (6.5), the availability of bikes at pick-up points (6.8) and finding available locking points at the bike-return station (7.3) were all highly rated. High marks were also awarded to aspects concerning the information received by users (6.6) and satisfaction with the response in the event of an incident (6.9). The length of the network of cycle lanes (4.6), its continuity (4.7) and its coexistence with pedestrians and motor vehicles (4.5) received the lowest ratings

### IV. DISCUSSION

Between 2009 and 2013, there was a substantial rise in bike trips in Palma, mainly due to a constant growth in cycle lanes and shared lanes during this period. However, in quantitative terms, the extent to which the BiciPalma bike-sharing scheme played a role in this increase is arguable. When the presented data is taken into account, if we look at the proportion of BiciPalma bike trips in relation to the total number of trips by bicycle, the percentage is fairly low. However, this is no reason to disparage bike-sharing schemes' contribution to the improved image of bicycles as a common, everyday means of transport or to the improved efficiency and safety of bike travel (FERNÁNDEZ-HEREDIA, MONZÓN and JARA-DÍAZ, 2014).

The analysed results show that BiciPalma has rather a limited coverage and spatial scope, both in terms of the geographical area that it covers and the population that it serves. Neither does it have a particularly high impact on cycle traffic in the city, if we compare it with the recorded cycle counts. As for time patterns in bike trips, these coincide with mandatory travel (i.e. the beginning and end of the working day), with peaks at the beginning of the

morning and at midday and troughs during the mid morning and mid afternoon. These flows coincide with the working hours of the public authorities or service-sector offices more than with the opening times of shops, a fact that was corroborated by our analysis of user profiles and characteristics. At the beginning of the day, outlying docking stations tend to be pick-up points, while those in the centre are generally used to return bicycles. During central hours of the day, generally speaking, the situation is reversed and many pick-up stations become bike return points. This coincides with time patterns in the city's general traffic.

From our analysis of the survey answered by the scheme's users, several relevant conclusions can be drawn. User profiles by gender and age show a higher male presence (60%). Over half (54%) the interviewees were aged between 35 and 55. As for their socioeconomic level and labour status, special note must be made of the low presence of unemployed individuals (8%) and the relative share of self-employed workers and employers (15%). Most of the scheme's users (77%) have university studies. As for their motivations in using the bike-sharing scheme, work, studies or the need to carry out different kinds of formalities were the most commonly given reasons, since over 50% of the users use the scheme either every day (20%) or almost every day (34%). BiciPalma's users generally live close to docking stations and so they walk to them.

## **V. CONCLUSIONS**

Non-motorized transport has become a key factor in the shift toward a modal system that involves more non-motorized travel and greater use of public transport as a means of reducing the presence of cars both in cities and outside them. Creating new infrastructure for motor vehicles as an end goal in transport planning is gradually being replaced by the concept of transport demand management. Increases in motor traffic can only lead to over-congestion for transport planners. However, a drop in motor traffic can be achieved by taking into account different types of land use and demographic densities, factors which planners can influence. Sustainable urban transport planning and policy decisions regarding its implementation entail measures and intervention processes aimed at changing and improving life in cities. Promoting the use of bicycles can go hand in hand with dissuasive car parks, traffic calming measures (30 km/h), priority high-occupancy vehicle and bus lanes, alternative working hours, car sharing, improved pedestrian areas, improved public transport and car park management. (RODRIGUE, COMTOIS, SLACK, 2009).

Demand management can be accompanied by other measures, such as paid use of infrastructure, the use of smart transport systems or goods traffic demand management.

BiciPalma can be seen as a minority form of non-motorized transport that has nonetheless managed to draw people's attention to bicycles and has thus contributed, in conjunction with the increase in the number of cycle lanes, to a sharp rise in this type of transport in Palma in recent years.

The analysis of BiciPalma's coverage, how it works, and the profiles of its users highlights its limited scope. It is used by one fourth of the resident population, it covers 10% of the city and it accounts for 10% of all bike trips in Palma.

Typical users have a mid-level socioeconomic status and they are mainly men aged between 35 and 55 with university studies. This points to barriers in access to the scheme by

younger members of the population or female individuals. The payment of a fee is presumed to be one of the main handicaps in access to the system, since only 8% of the users are unemployed. Its limited geographical coverage and difficult access for residents living outside Palma both condition its combined use with public transport as a means of access to the city centre from outlying car parks.

Within the context of a city where bicycle mobility tended to be scorned, as part of a general bid for a more sustainable system of mobility, BiciPalma has improved the image of bicycles in the city and extended their use to other types of users who would not normally opt for this type of transport. In turn, it has helped to make the public more aware of bicycles' use as an everyday means of transport in addition to their role in leisure activities.