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Empirical analysis of travellers' routine choice of means of transport in Barcelona, Spain

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ABSTRACT

The present study identifies groups of travellers according to their routine choice of means of transport in the context of the Barcelona Metropolitan Region. Clustering procedures are used to classify travellers according to the self-reported frequency of use of different travel modes. The extracted segments are then profiled with regards to their residence location, socioeconomic traits, access to a car, and other factors that relate to routines becoming habits – (low) use of travel information and disproportionate use of their preferred means of transport. This exercise is of great interest because the incidence of driving habits and other psychological determinants of (un)sustainable travel mode choice are under-researched factors in Barcelona. Data was retrieved from the *Survey of Daily Mobility of Catalonia 2006*. We identified seven relatively homogeneous segments of transport users, of which two groups are routine users of private vehicles for whom their modal choice is apparently disconnected from situational factors, namely *Motorcycle enthusiasts* and *Car drivers*. These groups also share common traits regarding their minimal use of travel information and narrow modal mix (unimodality). The results suggest that it may be valuable to explore the issue of driving habits formation in the context of Barcelona in depth, as it has implications for the design of environmental policy for transport.

1. Introduction

Transport puts a great deal of pressure on the environment. A special focus on travel mode choice seems inevitable given the disproportional contribution of private vehicles compared with their environmental impact. Travel behaviour is however complex and travel-related decisions involve many underlying factors. Despite the efforts of various policies to cut down private vehicle usage, physical changes advanced by strategic urban planning and transport taxes, people continue to drive, even if they have access to alternatives. This is why, nowadays, it is widely believed that in order to be more effective, environmental transport policies need to better account for bounded rationality (e.g. routines and habits) and the heterogeneity

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of travellers' preferences (Anable, 2005; Garcia-Sierra, van den Bergh, & Miralles-Guasch, 2015; Jensen, 1999; Krizek & El-Geneidy, 2007). Up until today, most of the literature regarding Barcelona's mobility has been focused on the determinants of modal choice urban form and built environment (Marquet & Miralles-Guasch, 2015a; Matas & Raymond, 2008; Muñiz, Galindo, & García, 2003). Gender, age and income differences have been analysed as well by Miralles-Guasch, Martínez Melo, and Marquet (2016), Marquet and Miralles-Guasch (2015b, 2014). The incidence of psychological factors has drawn much less attention (Garcia-Sierra & van den Bergh, 2014) despite being a fundamental part of travel behaviour and modal choice (Garcia-Sierra et al., 2015; Metcalfe and Dolan, 2012), and this has the potential to explain why homogeneous groups behave differently (Van Acker, Van Wee, & Witlox, 2010).

This empirical study aims at filling that gap by offering a first, exploratory approximation to the issue in the context of Barcelona's mobility. It focuses on the routine choice of a means of transport. Routines play a significant role in modal choice, since most daily travel is repetitive in nature (Thøgersen, 2006), especially on weekdays (Gärling & Axhausen, 2003; Schlich & Axhausen, 2003). Moreover, frequency of past behaviour is a proxy of habit (Triandis, 1977, 1980), whilst habits pose a real challenge to environmental transport policy aimed at behavioural change in order to realise more sustainable mobility (see Verplanken & Wood, 2006, for a review). A major concern is that people with strong modal habits tend to neglect relevant and compelling information about their travel choices (Gärling, Fujii, & Boe, 2001; Verplanken, Aarts, & van Knippenberg, 1997), including information about improvements to the accessibility of public transport and the increase in price of private transport. The aim of the article is to identify groups of travellers according to their routine choice of means of transport, and study them as socially-embedded groups. In this way, we can analyse common traits between groups and, more interestingly, the divergences in their daily strategies of modal choice. Cluster procedures are used to achieve this aim by classifying individuals according to their routine travel patterns (e.g. Bayarma, Kitamura, & Susilo, 2007; Hanson & Huff, 1986; Krizek, 2006). Data is retrieved from a general mobility survey, the *Survey of Daily Mobility of Catalonia 2006* (EMQ 2006). This is the last of this series of general mobility surveys and it involved the largest sample of individuals ever compiled for Catalonia and the BMR, and the largest set of variables, including self-reported frequency of use of different transport modes on weekdays. In addition, the groups identified are studied in regards to the determinants of transport mode choice, such as public transport provision at residence location, socioeconomic traits and access to a car.

The remainder of this article is structured as follows. Section 2 reviews the literature on the determinants of transport mode choice and clustering analysis for the study of travel behaviour. Section 3 introduces the methodology. Section 4 presents the empirical analysis resulting in seven behavioural segments or typologies of travellers, as well as the application of the findings for policy design. Section 5 concludes the study.

2. Literature review

2.1. The election of a means of transport

Regarding the choice of a means of transport, factors of different nature have an effect. Situational factors connected to the built environment like urban form are well-recognised antecedents of travel mode choice (e.g. Ewing & Cervero, 2001, 2010; Handy, Boarnet, Ewing, & Killingsworth, 2002), of which compact forms can facilitate a modal shift through the shortening of daily journeys and better access to public transport. Individuals' socioeconomic characteristics also determine modal choices. Income can restrain the frequency of use and the access to private modes of transport, while demographic variables, such as gender and age, shape the different use of transport means. In explaining why homogeneous groups of travellers in terms of situational and socioeconomic characteristics behave differently, psychological factors play a role (Steg & Vlek, 2009; Van Acker et al., 2010). Perceptions of how difficult or easy it is to shift the habitual transport choice, attitudes towards public transport and the car and norms concerning car use, all have been found to influence, to some extent, the preference for a certain means of transport, and the intention to change to another transport option (e.g. Abrahamse et al., 2009; Bamberg & Schmidt, 1999; Carrus, Passafaro, & Bonnes, 2008; Klöckner and Blöbaum, 2010). Meta-analytic results confirm the influence of attitudes, mediated by intention, on modal choice and in which intention explains 27% of the variance in use of sustainable transport alternatives such as public transport (Bamberg & Möser, 2007). The general consideration is that individuals select a form of transport depending on their opportunities and preferences, that is, through a rational scrutiny of the pros and cons of the available alternatives.

Individuals, however, are not always fully conscious of their travel behaviour. For frequently repeated journeys, studies found that only minimal thought is required to select the transport alternative (Aarts, Verplanken, & van Knippenberg, 1998; Verplanken & Aarts, 1999), suggesting that those choices may be non-deliberated, habitual choices (Aarts & Dijksterhuis, 2000; Gärling et al., 2001; Verplanken et al., 1997). Past behaviour may impact future behaviour through two different paths, studies show (Bamberg, Ajzen, & Schmidt, 2003; Davidov, 2007; Gardner, 2009; Ouellette & Wood, 1998; Thøgersen, 2006; Verplanken, Aarts, van Knippenberg, & Knippenberg, 1994). For repetitive behaviours that are enacted in stable contexts (routines), past behaviour can lead to habit formation. In this case, past behaviour directly influences future behaviour, and the resulting course of action is automatic and non-reasoned; i.e. not mediated by intention. For behaviours that are performed in less stable contexts, past behaviour contributes to the process of intention formation. The resulting course of action is thus deliberate and planned. Routines and past behaviour consequently contribute, together with perceived behavioural control, attitudes, norms and other determinants of modal choice, to preference formation.

Habit formation requires past actions, entailing positive outcomes (rewards), to be sufficiently repeated within stable contexts. Habitual choices rely on past behaviour and experience. However, habits and past behaviour are different concepts; all habits are based on past actions, but past actions are not necessarily habitual and may derive from the formation of repeated deliberated intentions (Klöckner & Matthies, 2004). This may create an identification problem because habits are difficult to measure. Traditionally, past behaviour was considered a proxy for habit, and frequency of past behaviour a proxy for habit strength (Triandis, 1977, 1980). Frequency of past behaviour can be directly assessed through questionnaires within survey settings, or inferred from travel diaries. However, there are more sophisticated indicators being used in experimental settings which capture the unconscious character of habits through a response-frequency questionnaire (e.g. Verplanken & Orbell, 2003). These are based on the automaticity of responses, the level of information used by respondents (a proxy for un-reasoned responses), and the extent to which habit is generalised across diverse choice contexts. We have incorporated these issues into our study of choice routines.

2.2. Classification analysis

Classification procedures in general, and cluster analysis in particular, have been increasingly used to study travel behaviour and to aid transport policy design. The corollary is the belief that travellers with different motivations and facing different constraints should be approached in different ways for effectiveness. Individuals in a cluster group share similar characteristics, this being their current behaviour or other personal traits, which help visualise the complexity of travellers' profiles and so create more tailored interventions.

In this context, most recent studies specifically dealing with travel mode choice focus on market segmentation by attitude. These studies group travellers according to their reasons for choosing their everyday travel mode, namely their attitudes towards different means of transport (Anable, 2005; Beirão & Sarsfield Cabral, 2008; Jensen, 1999; Outwater et al., 1854; Shiftan, Outwater, & Zhou, 2008). Attitudinal market segmentation is mainly used to examine the potential "switchability" of travellers to public transport means (i.e. identifying potential markets) and to design tailored strategies to better serve these "switcher" segments.

In regards to the study of travel routines, including modal habits, clustering methods have played a key role in demonstrating the repetitive character and relative stability of daily travel patterns. That is, it has been proven that daily travel behaviour, especially on weekdays, is fairly stable (Schlich & Axhausen, 2003). In this context, studies can be found that group individuals together according to their habitual travel patterns (e.g. Gärling & Axhausen, 2003; Hanson & Huff, 1986; Krizek & El-Geneidy, 2007). Moreover, Hanson and Huff (1986) argue that habitual travel choices can be connected to sociodemographic variables and other determinants of travel, such as residence location and choice of car ownership, which we will also investigate.

A further issue concerning travel habits is the fact that these may spread to other choice contexts, so-called habit generalisation. For instance, the habit of driving to work every morning can be generalised into making all (morning) journeys by car (Verplanken & Aarts, 1999). In this vein, "unimodality" indicates an indiscriminate use of a given travel mode, which can be a sign of habit generalisation due to a strong modal habit. There are studies that classify individuals according to their level of use of travel modes with an emphasis on travellers' multimodality *versus* unimodality (e.g. Diana & Mokhtarian, 2009; Nobis, 2007). Multimodality is considered a desirable behaviour from a sustainability perspective in contrast to car dependency and car habit, which are examples of unimodality. Nobis (2007) finds that multimodality is associated with urban environments, namely, large cities where public transport is primarily used, and that youths and elders show higher degrees of multimodality than middle-age adults.

3. Methodology

3.1. Study region

The BMR covers 10% of the Catalonian territory, including nearly 5 m inhabitants (about 70% of the Catalan population). It is divided into two metropolitan rings that extend outwards from the city of Barcelona (see Fig. 1). Barcelona and the first metropolitan ring are compact and diverse in land use, while the second metropolitan ring comprises of seven large cities or metropolitan sub-centres and their transport corridors, and combines both rural and low-density residential uses. The public transport network of the BMR is markedly radial, except within Barcelona city, and it shows some spatial deficiencies in access in suburban residential and employment areas, as well as in rural areas, mainly from the second metropolitan ring outwards. Public transport connections between the metropolitan sub-centres and the centre (Barcelona) are well-established along the seven transport corridors or axes. Self-reported use of public transport is relatively large, with all modes aggregated. Despite this, 47.2% of the population still report making frequent use of private vehicles (40.8% car and 6.4% motorcycle). This is a significant proportion considering that private vehicles are the principal source of CO_2 emissions in the BMR, being responsible for 40% of total emissions (in 2004); only 4% of the total CO_2 emissions from transportation in Barcelona originate from public transportation (ATM, 2008).

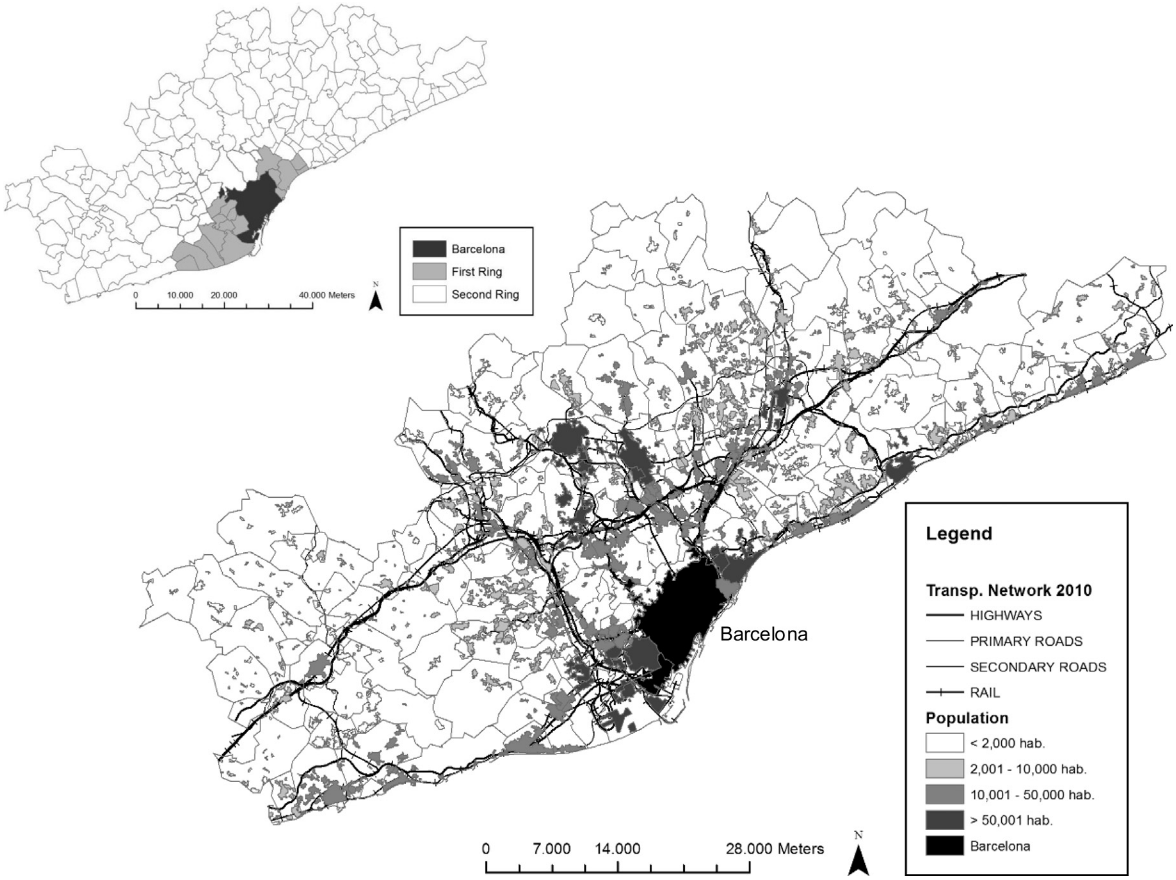

Fig. 1. Maps of the BMR with main features of the transport network, urbanised areas and populations of the municipalities, as well as of the division of the BMR territory into Barcelona city and the two rings (figure on top).

3.2. Data and survey questionnaire

Data was retrieved from a general mobility survey, namely, the *Survey of Daily Mobility of Catalonia 2006* (EMQ 2006). The main objectives of this general survey were to describe the daily travel patterns of the resident population of the BMR (and Catalonia), as well as to examine the subjective dimension of people's travel behaviour. The EMQ 2006 is an initiative of the Government of Catalonia in collaboration with the Metropolitan Transport Authority. This is the last of this series of general mobility surveys, and because of it, the EMQ 2006 is still used as the basis for the development of the mobility master plans for Barcelona and its metropolitan region.

The EMQ 2006 consists of two data matrixes (i.e. referring to different respondents). Matrix 1 retrieves information about the journeys made the day before the interview. The unit of study is ''main day journey'', including information on origin-destination, transport mode used, and duration of the journey. Matrix 2 involves information about people's self-reported use of travel modes, their use of travel information, as well as individual sociodemographic and other relevant information (e.g. vehicle ownership and average monthly expenditure in transport). This latter data set is the one used in the present study, and it involves, for the BMR, a total of 29,666 interviews (maximum error is 95% ± .58%) held following computer-assisted telephone interviewing (CATI) methodology (ATM, 2007). The use of twelve travel modes is assessed, including walking, cycling, several urban and metropolitan public transport modes, and two private modes (car and motorcycle). There are two metropolitan rail services, namely the RENFE Rodalies and the FGC; the RENFE Rodalies has more rail lines and covers a larger part of the territory. In addition, there is a tram service operating mainly within Barcelona but extending, both north and south, to some adjacent cities of the first metropolitan ring.

The sample is representative of the population of the BMR, consisting of 51.2% females (48.8% males). The ages of the respondents are divided into three segments: 16–29 years (22.2%), 30–64 years (58.7%), older than 65 years (19.1%). The average number of household members (including the interviewee) is 2.77 (SD = 1.151). Regarding their professional situation, 54.1% are employed or self-employed. With respect to residence location, 34.2% live in Barcelona city, 24.8% live in other municipalities within the first metropolitan ring, and 41% live in the second metropolitan ring. Of those not living in Barcelona city, 37.6% live in cities of more than 50,000 inhabitants. Both ''metropolitan ring'' and ''municipality size'' variables (i.e. variables related to residence location) provide information about public transport accessibility and are used as proxies for the level of public transport service (Miralles-Guasch & Tulla-Pujol, 2012). As a general rule, the smaller the municipality of residence and the farther it is located from Barcelona, the lower the access to public transport. Other travel-related information includes driving license and private vehicle ownership; 68.4% have a driver's license and 59.2% own a vehicle (either a car or a motorcycle/moped, or both).

Self-reported frequency of use of travel modes variables were the input variables in the cluster analysis (i.e. the segmenting variables).

1. *Self-reported frequency of use of travel modes* was measured for all twelve travel modes using a rating scale involving the levels 1 "often", 2 "sometimes", and 3 "never or almost never" (twelve variables in total). Reported frequency of use "often" primarily determined the profile of the segments, since it reflects a routine choice. Regarding survey settings, frequency of past behaviour can be considered an indicator of how "routinize" a choice is, whether measured by the number of times that a given behaviour had been performed in the past or by using adverbs reflecting frequency, such as "often", "sometimes", "rarely", as in our case (Ouellette & Wood, 1998; Verplanken et al., 1994). Besides, we used self-reported frequency of use of transport modes on week days. In our data journeys to work/education (i.e. commuting journeys) coincide with a working week of five days (Mean = 5.01, Stand. Dev. = .74) and around two trips of home-work/education (Mean = 2.44, Stand. Dev. = .85), indicating highly stable travel contexts.

Additionally, past frequency of behaviour is complemented with a measure of information usage, relevant for the assessment of the automatic and unplanned character of a traveller conduct. Specifically, what was measured was the frequency of information request about traffic conditions and/or public transport services. The actual questions asked are detailed below.

2. *Frequency of information request.* Four variables captured information use of both private and public transport users within a time frame of one year (12 months) before taking the questionnaire. Low use of travel information indicates automaticity of choice. Not requesting information or frequency of requesting information rated as "occasionally" was interpreted as an indication of low use of travel information, thus, signalling a non-reasoned conduct (perhaps a habit).
   a. In the past 12 months, have you requested information on how to go somewhere or about the traffic conditions? (1 "Yes", 2 "No").
   b. If "Yes" [referring to route or traffic information request], then how often? (0 "Occasionally", 1 "1–4 times month", 2 "> 4 times a month").
   c. In the past 12 months, have you requested information about public transport services? (1 "Yes", 2 "No").
   d. If "Yes" [referring to information request about public transport services], then how often? (0 "Occasionally", 1 "1–4 times month", 2 "> 4 times a month").

If only one travel mode is clearly predominant in the modal mix of a group, this is interpreted as a sign favourable to habit formation. In other words, unimodality indicates an indiscriminate use or abuse of a given means of transport that follows from the previous example of habit generalisation: moving from commuting to work every morning to making all (morning) journeys by car.

This choice information is completed with socioeconomic and demographic, residential location, as well as other travel-related information. These other variables were also used to subsequently profile the identified segments, and are:

3. *Socioeconomic and demographic.* Gender, age, employed/unemployed, level of education completed, and monthly household income. "Employed" stands for either employed or self-employed. The category of unemployed, on the contrary, includes besides the unemployed, the retired and pensioners, as well as persons choosing to stay at home and students.
4. *Locational.* Municipality of residence according to its number of inhabitants, and corresponding metropolitan ring. These variables are used as proxies of the access to public transport.
5. *Other travel-related variables.* Driving license, vehicle ownership, and monthly expenditure on private and public transport, the latter including taxis. Expenditure on private vehicles includes fuel expenses, fixed parking near home and other parking expenses, and road tolls.

3.3. Statistical analysis

Cluster methods help to reduce data (cases or variables) in a meaningful way. Cases (i.e. individuals) are classified into relatively homogeneous groups according to a predefined set of variables: the segmenting variables or *cluster variate* (Hair, Black, Babin, & Anderson, 2009). We use cluster procedures to classify travellers according to their self-reported frequency of use of transport modes, so as to identify groups of travellers sharing similar travel behaviour.

When analysing the data, we followed a sequential statistical process consisting of the following steps:

Step 1: Descriptive analysis. Frequency analysis of segmenting variables, namely self-reported frequency of use of different transport means.

Step 2: Cluster analysis. This step identifies different segments of travellers according to their self-reported frequency of use of different travel modes (i.e. input variables). The nature of cluster classification procedures is exploratory, meaning that their actual goal is to identify occurring groups emerging from the data, in contrast to forced, *a priori* chosen classifications. This is considered a positive trait of this procedure, in the sense that total reliance on researcher judgement is avoided. Firstly, hierarchical cluster (squared Euclidean distance, Ward agglomeration method) was used to determine the number of clusters (K) which best represented the structure of the data ($5 < K < 7$).[1] Subsequent non-hierarchical cluster repetitions using the k-means procedure were performed (trials for 4, 5, 6 and 7 clusters). Within-group homogeneity and between-group heterogeneity are maximised through this procedure.[2] The seven clusters solution provided the best discriminative result. 96.6% of the cases were satisfactorily classified within this solution (28,697 cases representing around 4 M people of the overall population of the BMR).

It is important to mention a few caveats related to the cluster analysis. Firstly, the segmenting variables were very lowly correlated (see Table 1), indicating that the variables have explanatory power for themselves. We therefore disesteemed performing a factor analysis prior to the cluster analysis.[3] Secondly, although being measured on an ordinal scale, it is common practice to use these types of ordinal variables to conduct statistical analysis, such as cluster analysis, appropriated for interval variables.

Step 3: Validation of the seven cluster solution through multivariate analysis of variance (MANOVA) and Bonferroni corrections. MANOVA has been undertaken to assess differences between group in terms of behaviour and to validate classification results. A statistically significant MANOVA effect was obtained through Pillai's Trace = 2.681, *p-value* < .001. The multivariate effect size was estimated at .447. The analysis was followed up by performing a series of one-way ANOVAs with the twelve variables of self-reported frequency of use of travel modes as dependent variables and the segments extracted as the independent variable. All of the ANOVAs were statistically significant (*p-values* < .001) suggesting that groups could be unique, in terms of their modal behaviour, and Bonferroni tests supported this finding. The effect sizes (i.e. partial η^2) of the twelve dependent variables ranged from .852 ("Car driver") to .037 ("Bicycle").[4] Effect sizes indicate the level of contribution of each variable in maximising dissimilarity between the groups. In this case, frequency of use of "Car driver" made the strongest contribution to differences amongst the seven behavioural segments extracted. This was followed by frequency of use of "Metro", "Tram", "Urban bus" and "RENFE Rodalies", which is consistent with the modal split of the BMR as described in the data.

Step 4: Segments' profiling. In this step bivariate analysis, crosstabs (with Chi-square and residuals tests), were used to:

(a) profile the segments according to their self-reported frequency of use of travel modes. The frequency "often" primarily determined the profiles of the segments. Each cluster was examined in terms of the *cluster variate* and a name was assigned describing the cluster's modal habits. Chosen modes "sometimes" and "never or almost never" were also examined and help to refine the profiles by providing an accurate picture of the complete modal mix of each segment.

(b) profile the segments according to their frequency of information request. Low use of travel information is used to capture whether the choice is more or less reasoned. These variables are analysed as part of the control of the proxy frequency of past behaviour.

(c) profile the segments according to their common socioeconomic, demographic, locational and other travel-related variables completing the behavioural profiles of the segments extracted. The objective of this step is twofold. On the one hand, it is used to provide a complete profile of each segment in what regards to established determinants of transport mode choice. On the other hand, it serves to validate the segments, that is, whether the segments are plausible—representative of what has been documented for the BMR in terms of mobility and demographics and mobility and territory.

4. Results

4.1. Descriptive analysis

Table 2 shows the self-reported frequency of use of all travel modes for the overall population of the BMR. A large majority of the population of the BMR, more than 70%, report walking "often". This places walking at the top of travel mode alternatives. The car is still the second most frequently used transport mode, used regularly by 40.8% of the population. The urban bus and metro are used by around 20% of the population. Other modes seem to be subsidiary, mostly used "sometimes".

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1 Hierarchical cluster was performed on a subsample of 10% of the cases (randomly selected), a solution for large samples (Hair et al., 2009).

2 K-means procedures are also deterministic, meaning that each case is classified into only one cluster meaning that cases belonging to the same cluster share similar characteristics regarding the variables used to classify the sample.

3 Factor analysis is used to group variables based on patterns of variation (i.e. correlation) (Hair et al., 2009).

4 Effect sizes (partial η^2) for the dependent variables are as follows: .171 for walking; .439 for urban bus; .087 for interurban bus; .623 for metro; .525 for tram; .411 for metropolitan rail RENFE Rodalies; .135 for metropolitan rail FGC; .049 for long-distance rail; .047 for taxi; .852 for car driver; .065 for motorcycle driver; and .037 for bicycle.

Table 1
Pearson's correlations.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Walking	1											
2. Urban bus	.16	1										
3. Inter-urban bus	.09	.20	1									
4. Metro	.19	.34	.14	1								
5. Tram	.06	.15	.12	.23	1							
6. Metropolitan rail (RENFE Ro.)	.14	.09	.17	.23	.09	1						
7. Metropolitan rail (FGC)	.10	.17	.09	.28	.09	.22	1					
8. Long-distance	.06	.10	.09	.15	.08	.21	.14	1				
9. Taxi	.02	.16	.03	.15	.06	.03	.10	.14	1			
10. Car driver	−.15	−.33	−.17	.19	−.07	−.06	−.08	−.07	−.12	1		
11. Moto driver	−.11	−.13	−.06	−.08	−.03	−.03	−.03	−.01	−.00	.07	1	
12. Bicycle	.05	−.07	−.01	.03	.02	.09	.04	.04	−.01	.14	.11	1

4.2. Cluster results and segments profiling

Classification analysis concluded with the seven cluster solution providing the best discriminative result (Table 3), where the seven clusters extracted proved to be relatively stable. This analysis has thus allowed us to pass from twelve to seven entities, each of which has a sufficiently large size, provided that the sample was indeed very large. The seven clusters extracted were then profiled into behavioural segments in a subsequent stage of the analysis. The profiles of the segments are based on the frequency of use "often", capturing travellers' choice routines. Modes characterising each segment are given by the mean values of the variables used to derive the clusters (Table 3). Only values that are significantly different compared to the overall distribution of the sample are considered for profiling. To this end, residuals were adjusted to ±1.96. The segment sizes are also included in Table 3. We found significant differences between the seven groups regarding the frequency of use of the different transport modes (*p-values* < .001). Each of the segments extracted has a unique behavioural profile, which was validated using MANOVA, including post hoc analysis using Bonferroni corrections (results included in Table 3).

Table 4 presents a summarised view of the segments' profiles based on the results from the bivariate analysis of segmenting variables of clusters. Overall, we have identified two segments or groups of users of purely private transport modes, namely *motorcycle enthusiasts* and *car drivers*. Both *mixed users (car drivers)* and *mixed users (public transport)* straddle two categories, namely, private transport users and public transport users, though they show opposite behaviours. *Mixed users (car drivers)* are mainly users of private modes, while *mixed users (public transport)* are mainly users of public transport. Together, the three segments of users of private transport account for more than half the population. Purely public transport users involve two different groups: *urban public transport users* and *edge public transport users*, which together with *mixed users (public transport)* represent over one fourth of the overall population. The main characteristic of public transport users is the combination of frequent use of public transport and frequent walking. This is not surprising provided the need to walk to stations/stops. Note that we have made a distinction between *urban* and *edge* public transport users as users from these two groups combine different public transport modes depending on their accessibility and, therefore have been into "urban" and "edge".

The routine choice of a means of transport was measured through the self-reported frequency of use proxy "often", also used to profile the segments. Choice routines might derive in the formation of habits. However, habits are rather more complex as they need stable contexts in order to form, and if strong enough these can be generalised. In addition, habitual users can be further identified by their use of travel information, which is low in this case. In accordance, we have captured this complexity through two theoretically based controls: (1) low use of travel information indicating automaticity of behaviour, and (2) unimodality. Unimodality, namely, when only one travel mode predominates the modal mix, captures the generalisation of a routine behaviour. Bivariate analyses were undertaken and frequency values of the "information request" variables are displayed in Table 5. Unimodality is inferred from each segment's modal mix.

There are significant differences between the seven groups for the variables on frequency of information request (*p-values* < 0.001). *Motorcycle enthusiasts* do not use travel information, thus suggesting the automaticity of their behaviour. *Car drivers* do not inform themselves about public transport services, yet they most significantly request information on traffic conditions, and they do this relatively often (more than four times a month over the past year). In spite of this, the overall use of information is low for all segments, thus, indicating that modal choices may be largely habitual, that is, automatically made. This may be challenging for designing information campaigns attempting to either attract public transport users or discourage the use of private vehicles. Of special mention is the group *mixed users (car drivers)*. This group displays a relatively high use of information about public transport services (and also about private vehicles), which may be encouraging from a policy perspective.

The generalisation condition is only strictly satisfied by two segments, *motorcycle enthusiasts* and *pedestrians.* However, *car drivers* have a very narrow modal mix of only three modes, where the car clearly predominates. Nonetheless further analysis of this group may be necessary to assess their accessibility to public transport alternatives.

Table 2
Frequencies of use of travel modes for the overall population of BMR (%).

	Never or almost never	Sometimes	Often
1. Walking	7.9	18.9	73.2
2. Urban bus	55.3	26.1	18.6
3. Inter-urban bus	81.1	13.8	5.1
4. Metro	45.6	29.3	25.1
5. Tram	89.1	8.5	2.4
6. Metropolitan rail (RENFE Ro.)	60.6	28.7	10.7
7. Metropolitan rail (FGC)	71.7	20.6	7.7
8. Long-distance rail	89.1	9.9	1.0
9. Taxi	72.7	23.6	3.7
10. Car driver	46.1	13.1	40.8
11. Moto driver	91.6	2.0	6.4
12. Bicycle	81.8	12.5	5.7

4.3. Demographic and locational characteristics

We further analysed the behavioural segments identified as socially-embedded groups. For this purpose, we have considered other choice determinants, namely socioeconomic and demographic, locational and other travel-related characteristics. There is evidence in the literature related to the BMR that all these variables correlate with behaviour (Cebollada & Miralles-Guasch, 2008; Miralles-Guasch, Martínez Melo, & Marquet Sarda, 2014). Thus, it could well be that these segments emerged from underlying structured social characteristics (Dominguez-Amorós & López-Roldán, 1996). We investigated this hypothesis to prove or disprove it. In addition, the demographic and locational profiling serves to further validate the segments extracted; segments' verisimilitude. Results from the bivariate analyses of these additional variables are displayed in Tables 6 (socio-demographics) and 7 (locational and other travel). All of them were significantly related to the segments extracted at a *p-value* < .001, hence indicating that differences exist among the social/territorial profiles of the seven segments.

Gender differences are remarkable; women are associated in relatively greater measure with the use of public transport, while men with private vehicles (Table 6). Income is associated with age, in that highest incomes are found for adults. We also expected monthly income to be indicative of transport modes used through transport expenses. Results show that groups of car users also belong to the highest income ranges. Moreover, for car users there seems to be a minimum income threshold of €1000 per month. Locational variables analysed were consistent among themselves (Table 7). Locational variables yielded results that were further consistent with the modal offer of public transport services within the BMR (see Section 3.2). Among residents from suburban areas, namely the First and Second rings, the car has a greater share, especially for residents of both medium- and small-sized towns. On the other hand, urban residents of Barcelona or of large cities from the First ring tend to rely more heavily on public transport. Three variables referring to other travel-related characteristics of travellers were analysed (Table 7). The variables "driving license" and "vehicle ownership" reinforced classification results. Monthly expenditure on transport was remarkably higher for frequent users of the car and consistent with income, as expected.

Adding all pieces of information together, the *urban public transport users* segment is most significantly formed of both young and elderly educated women, with a monthly income below €2000 and who are mainly unemployed. They are, to a large extent, residents of Barcelona, having no driving license or their own vehicle. *Car drivers* are mainly male adults, with a middle-level education (secondary school completed). Monthly income range is wide for this segment, which encompasses relatively high incomes and almost all are employed. They are mostly suburban residents from small and medium-sized towns inside the Second metropolitan ring, with a driving license and their own vehicle. Monthly expenditure on private transport in this segment is the highest, at around €120. The *mixed users (public transport)* segment is most significantly formed of young educated females, mostly unemployed and who are urban residents from Barcelona and other large cities within the First metropolitan ring. Their income range is €1000–€2000, and their expenditure on private transport is around €75 per month. *Edge public transport users* are mostly young, unemployed females with secondary-school education. They are mostly suburban residents from medium-sized cities within the First and Second metropolitan rings, having no driving license and owning a bicycle. The *Motorcycle enthusiasts* segment is most significantly formed of young females, with a low level of education. Monthly income is relatively low for this segment with no employment, living in Barcelona and other large cities within the First metropolitan ring; having a driving license and owning a motorcycle. *Mixed users (car drivers)* are mainly young adults, educated men, and almost all are employed. Monthly incomes are the highest. Significant residential locations for this segment are suburban medium-sized cities within both the First and Second metropolitan rings, having driving licenses for car and motorcycle, and owning a car. Monthly expenditure on private transport is relatively high. Finally, the *pedestrians* segment is most significantly formed of elderly females, with a low level of education and low income (below €1000 per month); mainly unemployed and, presumably, retired. The most salient residential locations are large suburban cities within the Second metropolitan ring, having no driving license and not owning a vehicle, and their monthly expenditure on private transport is the lowest, at around €50.

Table 3
Self-reported frequency of use of travel modes for each cluster. (Frequency in %.)

	1. Urban public transport users (12.1%)	2. Car drivers (26.1%)	3. Mixed users (public transport) (5.1%)	4. Edge public transport users (10.1%)	5. Motor-cycle enthusiasts (10.1%)	6. Mixed users (car drivers) (17.3%)	7. Pedes-trains (15.8%)	Sample average (96.6%)
Walking	2, 4, 5, 6, 7	1, 3, 4, 5, 6, 7	2, 4, 5, 6, 7	1, 2, 3, 5, 6	1, 2, 3, 4, 6, 7	1, 2, 3, 4, 5, 7	1, 2, 3*, 5, 6	
Often	**83.80**$^{++}$	56.40	**86.70**$^{++}$	**90.20**$^{++}$	39.20	**79.40**$^{++}$	**90.70**$^{++}$	82.60
Sometimes	13.80	**28.80**	11.20	8.60	**34.00**	17.90	8.20	18.90
Never or almost never	2.40	**14.90**	2.10	1.20	**26.70**	2.70	1.10	7.90
Urban bus	2, 3, 4, 5, 6, 7	1, 3, 4, 5*, 6, 7	1, 2, 4, 5, 6, 7	1, 2, 3, 5, 6, 7	1, 2*, 3, 4, 6, 7	1, 2, 3, 4, 5, 7	1, 2, 3, 4, 5, 6	
Often	**65.50**$^{++}$	1.40	**49.40**$^{+}$	18.20	0.00	12.90	18.70	18.60
Sometimes	**31.60**	6.90	**39.90**	**36.50**	13.40	**31.10**	**43.80**	26.10
Never or almost never	2.90	**91.70**	10.70	45.30	**86.60**	56.00	37.50	55.30
Inter-urban bus	2, 3, 4, 5, 6, 7	1, 3, 4, 5, 6, 7	1, 2, 4*, 5, 6, 7	1, 2, 3*, 5, 6, 7	1, 2, 3, 4, 6, 7	1, 2, 3, 4, 5, 7	1, 2, 3, 4, 5, 6	
Often	8.40	0.60	**13.20**$^{++}$	**13.80**$^{++}$	3.20	3.30	4.20	5.10
Sometimes	13.80	4.30	**26.70**	**25.70**	9.10	**15.50**	**17.80**	13.80
Never or almost never	77.80	**95.00**	60.10	60.40	**87.70**	81.20	78.10	81.10
Metro	2, 3, 4, 5, 6, 7	1, 3, 4, 5, 6, 7	1, 2, 4, 5, 6, 7	1, 2, 3, 5, 6, 7	1, 2, 3, 4, 6, 7	1, 2, 3, 4, 5, 7	1, 2, 3, 4, 5, 6	
Often	**70.30**$^{++}$	0.00	**67.00**$^{++}$	**40.40**$^{+}$	18.30	**36.10**$^{+}$	0.00	25.10
Sometimes	28.60	8.90	29.10	**44.70**	41.10	**59.00**	13.10	29.30
Never or almost never	1.10	**91.10**	3.90	15.00	40.50	4.90	**86.90**	45.60
Tram	3, 4, 5, 6, 7	3, 4, 5, 6, 7	1, 2, 4, 5, 6, 7	1, 2, 3, 6	1, 2, 3, 6, 7*	1, 2, 3, 4, 5, 7	1, 2, 3, 5*, 6	
Often	0.00	0.20	**33.90**$^{++}$	0.10	0.30	1.80	0.60	2.40
Sometimes	1.90	2.60	**66.10**	5.60	6.40	**10.90**	4.10	8.50
Never or almost never	**98.10**	**97.20**	0.00	**94.20**	**93.30**	87.30	**95.30**	89.10
Metropolitan rail (RENFE Ro.)	2, 3, 4, 5, 6, 7	1, 3, 4, 5, 6	1, 2, 4, 5, 7	1, 2, 3, 5, 6, 7	1, 2, 3, 4, 6, 7	1, 2, 4, 5, 7	1, 3, 4, 5, 6	
Often	0.70	1.80	**13.70**$^{+}$	**59.60**$^{++}$	0.40	**16.10**$^{+}$	0.00	10.70
Sometimes	**30.20**	19.60	**45.10**	**40.20**	14.50	**42.80**	22.00	28.70
Never or almost never	**69.20**	**78.60**	41.20	0.20	**85.00**	41.10	**78.00**	60.60
Metropolitan rail (FGC)	2, 5, 6, 7	1, 3, 4, 6	2, 5, 6, 7	2, 5, 6, 7	1, 3, 4, 6	1, 2, 3, 4, 5, 7	1, 3, 4, 6	
Often	17.40	1.30	**14.50**$^{++}$	**15.20**$^{++}$	3.20	**11.40**$^{++}$	2.10	7.70
Sometimes	**29.90**	11.10	**36.30**	**31.30**	10.00	**32.00**	11.60	20.60
Never or almost never	52.70	**87.70**	49.30	53.50	**86.80**	56.70	**86.30**	71.70
Long-distance rail	2, 3, 4, 5, 7	1, 3, 4, 6, 7	1, 2, 4*, 5, 6, 7	1, 2, 3*, 5, 6, 7	1, 3, 4, 6	2, 3, 4, 5, 7	1, 2, 3, 4, 6	
Often	1.10	0.20	**2.30**$^{++}$	**3.50**$^{++}$	0.60	1.00	0.20	1.00
Sometimes	**13.00**	4.20	**20.50**	**21.10**	5.00	**13.00**	6.40	9.90
Never or almost never	85.90	**95.60**	77.20	75.30	**94.40**	86.00	**93.40**	89.10
Taxi	2, 4, 5, 6, 7	1, 3, 4, 5, 6, 7	2, 4, 5, 6, 7	1, 2, 3, 5*, 6	1, 2, 3, 4*, 6*, 7*	1, 2, 3, 5*, 7	1, 2, 3, 4, 5*, 6	
Often	**7.20**$^{++}$	1.40	**5.80**$^{+}$	**4.50**$^{+}$	4.00	3.90	3.40	3.70
Sometimes	**35.80**	12.20	**37.00**	**26.90**	24.50	**28.10**	22.80	23.70
Never or almost never	57.00	**86.40**	57.20	68.60	71.40	68.00	**73.80**	72.70

(*continued on next page*)

Table 3 (*continued*)

	1. Urban public transport users (12.1%)	2. Car drivers (26.1%)	3. Mixed users (public transport) (5.1%)	4. Edge public transport users (10.1%)	5. Motor-cycle enthusiasts (10.1%)	6. Mixed users (car drivers) (17.3%)	7. Pedes-trains (15.8%)	Sample average (96.6%)
Car driver	2, 3, 4, 5, 6, 7	1, 3, 4, 5, 7	1, 2, 4, 5, 6, 7	1, 2, 3, 6, 7	1, 2, 3, 6, 7	1, 3, 4, 5, 7	1, 2, 3, 4, 5, 6	
Often	0.70	**89.50**[++]	**7.50**[+]	0.00	0.00	**90.10**[++]	0.00	40.80
Sometimes	**19.60**	10.50	**19.60**	**16.60**	**15.80**	9.90	9.70	13.10
Never or almost never	**79.70**	0.00	**72.90**	**83.30**	**84.20**	0.00	**90.30**	46.10
Moto driver	2, 4, 5, 6	1, 3, 4, 5, 6, 7	2, 4[*], 5, 6	1, 2, 3[*], 5, 6, 7	1, 2, 3, 4, 6, 7	1, 2, 3, 4, 5, 7	2, 4, 5, 6	
Often	1.40	**8.80**[+]	1.90	3.30	**21.60**[++]	5.00	0.90	6.40
Sometimes	0.70	**3.80**	0.50	1.70	1.60	**2.50**	0.30	2.00
Never or almost never	**97.90**	87.50	**97.60**	**95.00**	76.80	**92.40**	**98.90**	91.60
Bicycle	2, 3, 4, 6, 7	1, 5, 6, 7	1, 5, 6, 7	1, 5, 6, 7	2, 3, 4, 6, 7	1, 2, 3, 4, 5, 7	1, 2, 3, 4, 5, 6	
Often	3.50	**6.10**[+]	7.10	**8.50**[++]	3.20	**7.70**[++]	1.70	5.70
Sometimes	7.50	**18.00**	12.60	12.90	6.40	**18.70**	3.20	12.50
Never or almost never	**89.00**	75.90	80.30	78.60	**90.40**	73.60	**95.10**	81.80

Notes: Clusters' relative shares are given in brackets under the captions. Number series for each mode indicate a significant difference among groups (ANOVA *post hoc* Bonferroni tests, *p-values* < .001). Figures in bold indicate a statistically significant difference compared to the overall distribution for the sample.

[*] *p-value* < .05.

[+] Traits characterising a given segment.

[++] Most prominent traits characterising a given segment.

Table 4

Segments' profiles according to the self-reported frequency of use of travel modes.

Cluster/segment	Type profile
1. Urban public transport users (12.1%)	• Users of public transport modes. Main modes characterising this group are: urban bus, metro, and secondarily taxi. Use of public transport is combined with frequent walking • "Sometimes" use private motorised transport modes; mainly the car
2. Car drivers (26.1%)	• Users of (individual) private vehicles; car is their main mode, but combine it with frequent use of the motorcycle and the bicycle • "Sometimes" walk • "Never or almost never" make use of the public transport modes
3. Mixed users (public transport) (5.1%)	• Users of a varied mix public transport modes; main public transport modes characterising this group are: metro and tram, and secondarily interurban bus, FGC and regional train. Use of public transport is combined with frequent walking and, to a lesser extent, with frequent use of the car
4. Edge public transport users (10.1%)	• Users of public transport modes. Main public transport modes characterising this group are: RENFE Rodalies, and secondarily interurban bus, FGC (and bicycle). Use of public transport is combined with frequent walking • "Sometimes" use private motorised transport modes; mainly the car
5. Motorcycle enthusiasts (10.1%)	• Habitual motorcycle drivers • "Sometimes" walk or use the car • "Never or almost never" make use of public transport modes
6. Mixed users (car drivers) (17.3%)	• Mainly "car driver(s)", but in combination with *rail* public transport, namely metro, FGC, and RENFE Rodalies. They also "often" walk and cycle • Other public transport modes and taxi may be used "sometimes" • "Never or almost never" make use of the motorcycle
7. Pedestrians (15.8%)	• Habitual pedestrians • "Sometimes" use urban and interurban buses • "Never or almost never" use private transport modes or public transport modes other than the bus

Note: Clusters' relative shares are given in brackets.

4.4. Application for policy

Overall, the results from the present study provide a more accurate picture of the segments' daily modal behaviour, residential location and socioeconomic characteristics, and this information is useful to inform policy design. In total, we have identified seven segments or typologies of travellers in the context of the BMR. This is consistent with results from similar

Table 5
Information request of each segment, control for habit construct. (Frequency in %.)

	Urban public transport users	Car drivers	Mixed users (public transport)	Edge public transport users	Motor-cycle enthusiasts	Mixed users (car drivers)	Pedestrians	Sample average
Requested for private vehicle (No)	**82.40**	63.80	**78.80**	**78.90**	**83.00**	57.30	**91.70**	73.90
Frequency (Private vehicle)								
Occasionally	**79.40**	69.00	72.60	**77.90**	64.40	67.40	**77.20**	70.40
1–4 times month	14.10	20.60	20.30	14.60	**26.60**	**23.40**	17.90	20.70
>4 times a month	6.50	**10.40**	7.20	7.50	9.00	9.20	4.90	8.90
Requested for public transport (No)	71.20	**79.00**	65.30	62.90	**81.20**	60.80	**88.90**	74.20
Frequency (Public transport)								
Occasionally	75.50	**86.20**	71.30	73.60	80.50	74.50	**84.00**	78.00
1–4 times month	18.30	11.80	**20.60**	**20.00**	15.80	**20.30**	12.30	17.20
>4 times a month	**6.20**	2.00	**8.00**	**6.40**	3.70	5.20	3.60	4.80

Notes: Refers to information requests made in the past 12 months. Figures in bold indicate a statistically significant difference compared to the overall distribution for the sample.

Table 6
Socioeconomic and demographic characteristics of each segment. (Frequency in %.)

	Urban public transport users	Car drivers	Mixed users (public transport)	Edge public transport users	Motor-cycle enthusiasts	Mixed users (car drivers)	Pedestrians	Sample average
Gender (Female)	**66.70**	33.60	**58.20**	**60.30**	**55.90**	37.40	**73.40**	51.40
Age								
16–29 years	**21.90**	17.10	**28.50**	**33.50**	**20.50**	**20.40**	7.80	19.40
30–64 years	57.00	**75.60**	53.70	51.20	46.50	**71.00**	45.50	60.80
More than 65 years	**21.10**	7.30	17.80	15.30	**33.00**	8.60	**46.70**	19.80
Level of education completed								
No education	5.00	2.20	4.40	5.50	**16.40**	1.50	**21.70**	7.50
Primary education	31.70	34.70	30.70	32.00	**39.80**	24.20	**51.20**	35.20
Secondary education	**37.30**	**40.40**	**39.80**	**40.10**	27.60	**38.50**	19.00	34.80
College education	**26.00**	22.60	**25.00**	22.40	16.10	**35.90**	8.00	22.50
Other	0.10	0.10	0.10	0.00	0.10	0.00	0.10	0.10
Monthly household income								
<1.000€	**24.90**	9.40	22.50	**25.40**	**37.70**	8.40	**51.20**	22.80
1.000–2.000€	**43.30**	**41.70**	**42.60**	**42.00**	34.90	39.10	34.20	39.60
2.000–3.000€	21.10	**29.70**	21.00	21.40	18.30	**32.20**	10.00	23.60
3.000–4.000€	6.30	**11.90**	8.90	7.80	5.80	**12.60**	3.00	8.80
4.000–5.000€	2.60	**3.90**	3.60	1.80	2.30	**4.50**	0.80	3.00
>5.000€	1.80	3.50	1.40	1.60	1.10	3.20	0.80	2.30
Individuals in the household (group average)	2.62	2.99	2.83	2.76	2.55	2.85	2.37	2.74
Employed[a]	48.50	**77.20**	46.60	47.90	42.30	**72.80**	24.30	55.90

Notes: Figures in bold indicate a statistically significant difference compared to the overall distribution for the sample.
[a] Refers to current professional situation and involves two categories: "employed" and "unemployed", where the category "unemployed" includes the unemployed, retirees and pensioners, persons engaged in household chores and students.

studies identifying between four to eight relevant segments of travellers (Anable, 2005; Beirão & Sarsfield Cabral, 2008; Diana & Mokhtarian, 2009; Krizek, 2006; Shiftan et al., 2008). From the segments identified, those more challenging from a policy perspective are routine users of private vehicles: *motorcycle enthusiasts* and *car drivers*. These groups are formed of users of purely private transport modes who make minimal use of travel information, thus it is recommendable to further study their habit conditions, if any. Regarding *car drivers*, one can argue that this behavioural segment is constrained by their residential location and subsequent limited access to public transport alternatives. Nonetheless, for *car drivers* residing in large cities (Barcelona and other cities over 50,000 inhabitants), it is very likely that they have viable alternatives to the car for most of their daily journeys. *Edge public transport users* also have to deal with the same built environment conditions and public transport offer and, in spite of this, they regularly use public transport. The use of the car could thus be reduced, at least in these large cities, through stringent transport policy.

Table 7
Locational and other travel-related characteristics of each segment. (Frequency in %.)

	Urban public transport users	Car drivers	Mixed users (public transport)	Edge public transport users	Motor-cycle enthusiasts	Mixed users (car drivers)	Pedes-trians	Sample average
– Locational								
Municipality size (inhab.)								
<2000	0.00	**1.30**	0.00	0.20	0.50	0.60	0.40	0.60
2000–10,000	0.60	**13.60**	1.60	5.40	5.00	7.50	4.70	7.00
10,000–50,000	3.20	**29.10**	15.10	**24.70**	15.30	**22.30**	19.40	20.40
>50,000	23.20	**42.30**	29.20	**39.70**	36.00	37.10	**43.30**	37.50
Barcelona	**72.90**	13.60	**54.10**	29.90	**43.20**	32.40	32.30	34.40
Metropolitan ring								
Barcelona	**72.90**	13.70	**54.10**	30.00	**43.30**	32.50	32.40	34.50
Rest of first ring	20.60	21.80	**37.00**	**27.60**	**30.30**	**25.80**	23.10	24.90
Second ring	6.50	**64.60**	8.90	**42.30**	26.40	**41.70**	**44.50**	40.70
– Other travel								
Driver license								
Motorcycle (Yes)	18.40	**44.10**	19.90	21.60	**31.00**	**38.90**	11.60	29.60
Moped (Yes)	8.50	**30.40**	9.80	10.40	**21.60**	**23.90**	5.90	18.40
Car (Yes)	47.20	**100.00**	50.30	41.10	41.20	**100.00**	30.10	67.00
Vehicle ownership								
Motorcycle/moped (Yes)	7.90	**18.30**	8.30	15.40	**48.60**	12.30	8.70	16.80
Car (Yes)	61.80	**100.00**	67.10	57.30	58.20	**100.00**	58.40	86.09
Bicycle (Yes)	19.60	**37.30**	**30.00**	**32.60**	17.30	**39.00**	10.30	28.00
Monthly expenditure[a] *(€) (group average)*								
Private vehicle	67.32	117.92	74.73	57.02	54.30	103.02	52.96	101.61
Public transport	25.24	8.86	28.42	32.70	14.97	20.18	11.39	19.78
Public transport + taxi	33.65	15.09	37.63	38.58	20.83	26.23	16.44	25.95

Notes: Figures in bold indicate a statistically significant difference compared to the overall distribution for the sample.
[a] Monthly expenditure is only accounted for modes used.

Mixed users (car drivers) and *mixed users (public transport)* are both interesting groups from a policy perspective. They show opposite behaviours and personal profiles, thus supporting the idea that different types of travellers may need to be approached in different ways for the effectiveness of policies. *Mixed users (car drivers)* are mainly middle-aged, educated males living in suburban medium-sized cities and are mainly car users, while *mixed users (public transport)* are young educated females living in large cities who mainly use public transport. *Mixed users (car drivers)* can be considered a strategic target of policy measures aimed at behavioural change (i.e. potential mode switchers), since these travellers regularly use both private and public transport modes, and travel information. We therefore end this study by reflecting on how our results can be useful to transport planners in order to create tailored interventions, specifically for *motorcycle enthusiasts* and *car drivers*, and *mixed users (car drivers)* (also car users). The size of each segment is the first relevant result for policy. These results can be mapped on different geographic scales, showing the distribution of the behavioural typologies by municipality size. This information could offer good guidance for designing municipal transport plans. The distribution of the segments along with the socioeconomic data provide powerful information to determine where to intervene and how to target the groups. As way of illustration, Fig. 2 shows both the segments' sizes (number of individuals) and their spatial distribution within the city of Barcelona, the largest municipality with the highest offer of public transport in the BMR. Data from the EMQ 2006 is stratified into 63 transport zones in Barcelona city, whereby transport zones are defined according to the size of the municipality and the level of provision of transport infrastructure. In addition to the segments' distribution in Barcelona, concrete information is also provided about the offer of public transport in each location (i.e. transport zone). For each of Barcelona's transport zones, we provide information on the density of public transport stations/stops, that is, on the access to alternatives to the private vehicle—high, medium and low. The offer of public transport by segment location along with the demographic data provide sufficient information for the identification of these conflictive segments and their requirements.

Note that the distribution of the segments is largely independent of the offer of public transport (around one third for each density strata), thus suggesting that it may be valuable to explore in depth the issue of driving habits formation, at least in Barcelona. For *motorcycle enthusiasts*, their distribution is 35.90%, 35.20% and 29.00% in low, medium and high density transport zones, respectively. For *car drivers* it is 36.30%, 32.30% and 31.40%. Lastly, for *mixed users (car drivers)* it is 37.20%, 28.90% and 33.90%. In particular, for *car drivers*, their distribution by offer of public transport is roughly one third. From the variables studied, those that appear to be relevant for the modal choices of these groups are either socioeconomic (see Section 4.2) or related to the formation of habits. The attitudinal variables (preferences) could not be studied here. Consequently, it is recommended that future analysis focus on the causal relationships between the traveller's socioeconomic

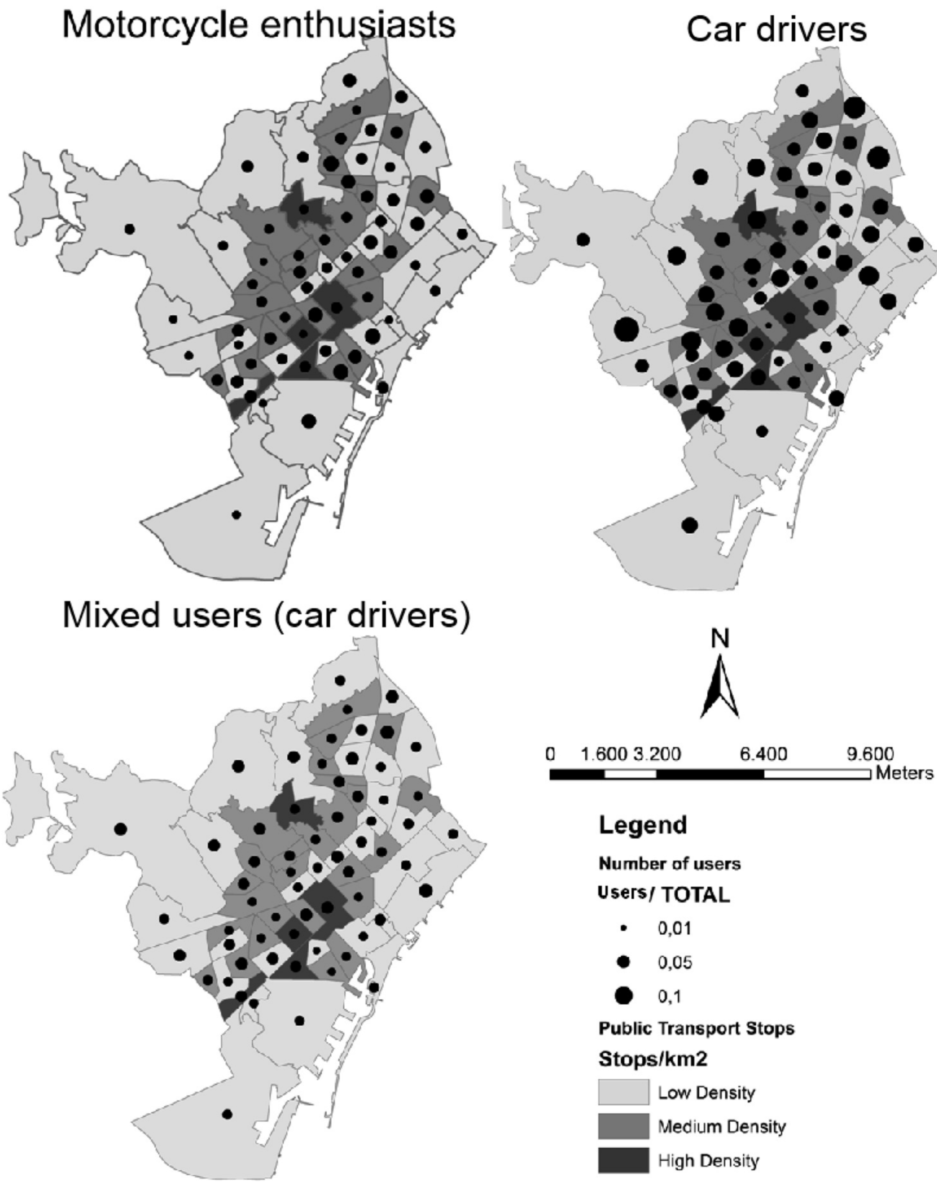

Fig. 2. Map of Barcelona with the spatial distribution, by transport zone and density of public transport stations/stops, of the three segments making a frequent use of private transport means.

profile and attitudes towards transportation modes, as well as the strength of the habit, so as to determine their relative contribution to modal choice.

5. Concluding remarks

As a central part of this study, a cluster analysis has been performed on a sample of travellers from the BMR. The aim was to identify groups of routine users of private modes representing a policy challenge. Seven segments were identified, according to the self-reported frequency of use of travel modes, namely *Urban public transport users*, *Car drivers*, *Mixed users (public transport)*, *Edge public transport users*, *Motorcycle enthusiasts, Mixed users (car drivers)*, and *Pedestrians.* Data was retrieved from a general mobility survey, which guarantees close to full representation of the BMR population. The modal behaviour of the segments was completed with socioeconomic and demographic, locational and other travel-related information. In this way, not only well-recognised determinants of travel mode choice could be connected to all the aforementioned. The groups' location and socioeconomic characteristics provided relevant information, which can be used to design tailored polices, in certain areas, for the groups using private means of transport.

A first step was establishing whether psychological factors connected to routines and habit formation might be playing a role in travel behaviour in Barcelona. Through this study we have demonstrated how groups of similar residence location and socioeconomic status resolve their daily journeys through different transport strategies of mode choice. Thus, underlining the importance of assessing psychological factors, and their relative influence on BMR's mobility, for future design of transport policy. In this vein, we found two groups of routine users of private modes, namely users of the motorcycle or *Motorcycle enthusiasts*, and users of the car or *Car drivers,* for whom we recommend exploring in depth the issue of driving habits formation in contraposition to the influence of socioeconomic determinants. These groups can, at least, be tackled within large cities through stringent transport policy, forcing them to change and rethink their current habits. As for *mixed users (car drivers),* further research will be necessary on a local scale to determine the best way to approach them; either by improving access to public transport for their current car journeys, or by changing their perceptions and attitudes towards the car by means of psychological strategies.

Lastly, this study demonstrated how powerful classification procedures are when identifying targetable groups for policy interventions. The strength of this approach lies in its simplicity and effectiveness to be translated into specific strategies by using the additional information on the groups' actual constraints for modal change, these being situational, socioeconomic, psychological (habits), or a mixture of them all.

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