Boletín de la Asociación de Geógrafos Españoles N.º 64 - 2014, págs. 461-465
I.S.S.N.: 0212-9426

AN ACCESSIBILITY ANALYSIS TO THE CITY BUS STOPS IN MÉRIDA (SPAIN)

José Antonio Gutiérrez Gallego
Rosa Berrocal Nieto
Enrique Eugenio Ruiz Labrador
Departamento de Expresión Gráfica. Escuela Politécnica. Universidad de Extremadura
jagutier@unex.es, rosa.berrocal@juntaextremadura.net, eruizl@unex.es
Francisco Javier Jaraíz Cabanillas
Departamento de Ciencias del Territorio. Universidad de Extremadura
jfjaraiz@unex.es
Jin Su Jeong
Departamento de Expresión Gráfica. Centro Universitario de Mérida. Universidad de Extremadura
jin@unex.es

I. INTRODUCTION

During recent years, the transport network designed in cities considered as the private one on the means of universal mobility vehicle. Although it is logical to think that its use is necessary and also enhances good quality life, increasing motorization and ever-increasing use of this transport mode which adversely affect the environment of cities and create tensions in public space. To alleviate these negative effects, professionals, policy makers and planner have begun to design sustainable urban mobility plans, instruments that manage a set of actions aimed at implanting sustainable forms of displacement and rationalizing the use of private vehicles.

One of the most applauded transportation alternatives in this sense is based on increasing the modal distribution of displacements giving priority to those that are collective, especially when there are certain social groups that do not have sufficient financial resources (children, adolescents, seniors, etc.) and who need to have this second type of transportation to carry out forced displacements (job and/or education) and not forced ones (equipment and/or services). Thus, the growth of urban bus passes by previously analyzing the pedestrian accessibility degree of service as a determinant. This allows to diagnosing the offer's validity and also improves that people will choose the collective mode instead of private one. For instance, if it is easy to access to the nearest bus stops from the house, users will be more receptive to use this mode of transport.

Within the technical work carried out the municipal pilot project for the sustainable mobility promotion in the city of Mérida (Spain), this research includes it to identify the status of collective public transport mobility, the urban bus for the citizens of Mérida, and within this, the determination of the service accessibility degree by the user of the potential urban population. Taking into account all these premises, this article presents a methodology that allows to analyzing the accessibility of the resident population in Merida at the urban bus service, based on the same population distribution. The Extremadura town bus service is managed by the subsidiary city hall, the urban transport of Mérida. This service is composed of 9 lines that together reach a total length of 107.53 km, scattered throughout the city. The average length of each route assigned to a line is 12 km. This whole journey is complemented with a total of 80 stops distributed by the specific urban nucleus. The whole vehicles are available to perform this service and consist of 15 buses with average 81 seats per vehicle. To obtain this accessibility, there are many variables which need to be calculated such as road permeability (or individual accessibility to the service), potential areas of the service itself (or minimal access time) and absolute or potential accessibility according to its territorial configuration in the city. This methodology is applied to the city of Mérida, located in the centre of Extremadura region and the west of Spain. That city has around 56,500 resident populations, which adds a daily floating population, around 10,000 people, owing to its regional capital status and administrative centre reference. This situation implies some important daily flows of entrance and exit of vehicles to and from other population nuclei, from the urban periphery to the administrative centre. This volume of displacement, however, causes collapses in the main transport arteries of the city because of the massive private vehicle use and the confluence of a large volume of users in a few specific areas of the city and to specific hours of the day. For instance, their mobility problems are aggravated by its peculiar structure and urban plot such as Christian, Roman and Arab ruins. These problems would have to add two important effect-barriers that greatly channelled road traffic: the Guadiana and Albarregas rivers and the route followed by the railway. All of these factors lead to parking problems and phenomena of congestion that characterize this area.

II. METHODOLOGY

The variables used for the determination of accessibility to Mérida city bus stops were calculated with the support of a geographical information system (ArcGIS 9.3). The process required the modelling of the territorial system (demographic data of Mérida) and transport (road network of the municipality in Mérida). Modelling network includes all town routes of the citizens of Mérida, whether they are owned either by municipal, regional or national. On the other hand, in the case of the territorial system modelling, those nodes that identified themselves as the centres of attraction (urban bus stops) and grouped the population by stretch roads correspond to the variable population according to the year of 2009 data from the national institute of statistics (INE: Instituto Nacional de Estadística) of Spain. Therefore, 80 stops that comprise the urban bus network in Mérida could be considered as centres of attraction.

In this sense, we can take into account three elements understood as a fundamental analysis type: offer points (the urban bus stops in Mérida); potential demand (the population

distribution in Mérida by household population); the distance that separates the potential demand of offer points (distance through the network roads). Once the transport network, the network stops, the city and the matrix source are targeted at households generated through the network, implemented in the geographic information system (GIS), it could be calculated through the algorithms of roads' minimum travel time. The travel time by calculating the road network from the city of Mérida was estimated based on the impedance of the same and average displacement speed of pedestrians. Using this manner, we calculated the travel time of each arc from the speed type and length.

With the calculated travel time, the variables were determined to employ the accessibility analysis to the bus stops (the population extent of accumulated or potential opportunities taking 5 and 10 minutes walking from the bus stops and the absolute accessibility indicator and the minimal access time from households to bus stops), combining these values with the territorial system data according to the formulations (Monsoon et al., 2005). The data corresponding to the location of the service stops were taken by the observation with the global positioning system (GPS); the data relating to the occupation of the bus were collected through gauging each vehicle service, scoring the number of get on and get off a bus at each stop along with the vehicle occupation between bus stops). After the data collection period from the urban bus service in Mérida, a total of 586 survey respondents were recorded, showing 11.89% of the average monthly bus users (4,927 persons) according to the data reported by the bus company named Transportes Urbanos de Mérida SL. The number of persons surveyed by bus line and day was 66 persons, which meant 10.71% of the total number of bus users per day and bus line 616 according to the bus company. On the other hand, as regards the potential demand of the citizens of Mérida, we examined the households' population-level, starting with postal addresses provided by the city council of Mérida.

In terms of the network characteristics, we used the calculations that an optimum velocity on foot is 3.83 km/h (638 metres by 10 minutes walking). This speed, as mentioned above, takes into account the various types of possible mobility for elderly, children or persons with reduced mobility (Knoblauch et al., 1996; Muñoz-Raskin, 2010). With this average pedestrian speed, we also considered the possible particularities of the circulation by the transport network (pedestrian interruptions, crossings of streets, obstacles, etc.). Thus, starting from the pedestrian average speed of different lengths of each network section was calculated to the impedance (resistance that presents each arc network to be crossed) and measurement in travel time, according to the expression of simple linear motion that relates to space with the flow rate (pedestrian in this case).Thus, it is necessary to clarify that it departed from the premise of the road network incorporated into this study lacking a full permeability (or total accessibility to public transportation). This figure of 3.83 km/h doing there is an overestimation of the existing accessibility. To set all the variables used in the determination of accessibility, we generated a point-to-point matrix through the network, taking the households as the origin points and the destination points. Thus, a data table contained the information corresponding to the travel time and the distance from each household to each bus stop of Mérida city bus network.

With all of this information, the data was calculated as already mentioned above: 1) individual accessibility or road permeability of passers-by from households to bus stops; 2) the potential areas of service or minimum access time to each bus stop, measured in

outline; and 3) the potential accessibility of service or accessibility that provides the bus driven by its settings. The first calculated indicator is the measure of cumulative opportunities or potential of population, which consists of the amount position of population or economic activity that falls within a certain limit of distance or time, with respect to one or more selected points (bus stops). If these points represent the location of equipment or services, this indicator defines the amount of potential demand, existing in own resident environment. As a case study, we discussed the potential population that accesses to Mérida bus network stops located within 5 to 10 minutes walking of them. The time between 5 and 10 minutes walking is a determinant to know psychological barriers to pedestrian movements as introduced and estimated (Gutierrez et al., 2000, 2002). The second calculated indicator is the absolute accessibility that evaluates the degree of interconnection of one point with the rest points in the study region. In this case, the households have been linked to bus stops, determining the degree of absolute accessibility based on the occupation of these and the minimum time of access from the households. It calculated the weighted average of the minimum time that separates each household with respect to the bus stops through the transport network, whereas the occupation of such stops as a weighting factor. Finally, estimated parameter of minimal access time belonged to the absolute accessibility indicator. This shows the minimum time from any household source to the nearest stop. To obtain this parameter as a variable for analysis in this study, we considered the distance, routes that must elapse with the average speed (in this case, the pedestrian walks 3.83 km/h average speed). The geographical location of the households and characteristics of the network stood out as important elements in regards to the results extracted from the analysis of this last variable.

III. RESULTS

In regards to population or accumulated or potential opportunities obtained the variable results, they extracted 28 bus stops which the service attracts a volume of nearby population (i.e., persons who had access to them in less than 5 minutes walking) which was between 1,000 and 1,500 inhabitants. This is due to its location in residential areas with single-family building typologies. In addition, the surroundings of these stops are located in the sports and educational endowments of the city. Therefore, the population density in this area is not too high. The 33 bus stops gave the access service less than 5 minutes walking for between 1,500 and 3,000 inhabitants. This percentage responds to its location in residential area but not with the homes of collective character (with the exception of San Juan neighbourhood, where combines single-family homes but not with a significant volume of resident population), so the population density is greater than in the case described above. In contrast to previous cases, 7% of urban bus service stops just accessed a volume of more than 3,000 inhabitants in less than 5 minutes walking on foot. This high potential responds to its location in the strategic areas of the city (the location of the most important equipment). There are collective residential areas with a high population density. However, if we extend more than 10 minutes walking travel time, we can see how most of the stops on the network (total 72%) outweighs the potential volume of population established the maximum (3,000 inhabitants), which gives a clear view of the degree of proximity of the service.

In terms of absolute accessibility, we can say that it detected a characteristic feature of the urban transport network for the citizens of Mérida; in areas of low accessibility, tending to locate stops that pass a number of low lines of transportation. This makes the absolute area accessibility reduced because a user who lives near these stops does not have the same ability to access to all the services offered to another user who lives in stops through which passes one greater number of lines. The opposite occurred more in the central areas of the city where had more a number of stalls and flyover lines, allowing the same users to have more possibility of access to all offered goods on the concentrated city.

Finally, the highlights of the analysis described the minimal access time was 86% of the total population of Mérida that had less than 5 minutes walking to a bus stop and 10% was less than 10 minutes walking from a stop. On the contrary, only remaining 4% residents had a bus stop more than 10 minutes walking. These closest stops are located in outlying areas of the city and correspond to stops that have a smaller number of lines of step and higher frequencies of service.

IV. CONCLUSIONS

After the study we have conducted, the main conclusions are summarized that there is a good distribution of bus stops in the city and with a high accessibility to the city bus. Also, it can be said that the network stops have a high demand potential for residents (72% of them have less than 10 minutes walking to a bus stop, potential population of 3,000 inhabitants). The configuration of the offered service network is also suitable not to mention that the urban central area presents a high accessibility to the bus. On the other hand, it shows that access time to bus stops for the most of the population is very low (86% citizens can access to a bus stop in less than 5 minutes walking). Finally, this study presents the evidences of the method validity as to evaluate the distribution of urban bus stops, regarding the location of the resident population at the household level.