ISSN 0798 1015

REVISTA ESPACIOS

HOME Revista ESPACIOS ÍNDICES A LOS AUTORES

Vol. 38 (Nº 16) Año 2017. Pág. 16

The influences of perceptions in bicycle demand for users with the same socioeconomic characteristics

Las influencias de las percepciones en la demanda de bicicletas para los usuarios con las mismas características socioeconómicas

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Recibido: 10/10/16 • Aprobado: 10/11/2016

Content

ABSTRACT:
In this paper we analyzed the potential demand for the use of the bicycle as an alternative transport for college students and employees commuting in any area of the city of Barranquilla where currently there is not an infrastructure for this mode. For the analysis, we evaluated a simple discrete choice model incorporating perceptions variables. Our results indicate that the existence of an adequate and sufficient road infrastructure can positively affect the individuals' decision, and could be improved by providing cycle facilities in campus like parking spots and showers or places where people can change and save clothes if necessary. We also demonstrated that individuals with the same socioeconomic characteristics and the same available alternatives, can choose different modes of transport, and their perceptions can influence their choice.
Key words: Cycling, Discrete choice models, Perceptions.

RESUMEN:
Con esta investigación se analizó la demanda potencial para el uso de la bicicleta como alternativa de transporte para estudiantes universitarios y empleados en un área de la ciudad de Barranquilla, donde actualmente no se cuenta con una infraestructura para este modo. Para el análisis, se evaluó un modelo simple de elección discreta incluyendo variables de percepciones. Nuestros resultados indican que la existencia de una adecuada y suficiente infraestructura puede afectar positivamente la decisión de los individuos, y podría mejorar si se brindaran ciclo facilidades en las instalaciones, como aparcamientos y duchas o lugares donde las personas se puedan cambiar y guardar ropa de ser necesario. Además se demostró que los individuos con las mismas características socioeconómicas y con las mismas alternativas disponibles, pueden elegir distintos modos de transporte ya que sus percepciones pueden influir en su elección.
Palabras clave: Bicicleta, Modelos de elección discreta,

	Percepciones.

1. Introduction

In the big cities of the world, a process of change has begun with a view to include sustainable urban transport such as cycling in the mobility of citizens in all the trips that take place daily. In recent years the daily trips by bicycle have increased to over 5% worldwide (Cervero, 2005). Besides this fact, recent investigations indicate that cycling for transportation can increase physical activity and reduce weight (Teschkea et al, 2012). People who cycle or walk to work are more likely to be fit and less likely to be overweight or obese than those who use motorized modes (Teschkea et al, 2012). Furthermore, the world obesity health problem has led to the need to encourage the use of the bicycle as a sustainable alternative urban transport mode (Martens 2004; Krizek and Roland 2005; Sælensminde 2004; Pucher and Buehler 2006; Ortúzar et al, 2010).

In order to promote sustainable urban mobility, authorities have been working on the public transport by designing policies based on people's perception of the services received (dell'Olio et al, 2010); but they also have worked on the planning and promotion of alternative transport modes, such as the bicycle, allowing it to become more efficient and appealing to potential users.

The aim of this research is to present an approach of the possible demand for the use of the bicycle as a transportation alternative for employees and college students commuting in an area of the city of Barranquilla. We introduce additional attributes than the commonly used for these models, like travel time and cost, we analyze the effect of the existence of road infrastructure and cycle facilities in the city, and some individual socioeconomic variables like stratum and gender. The first one involves the perception in the city infrastructure constructed for this mode and the other considered variables are related to the social and economic conditions of the object people of this study.

2. Model framework

The literature developed in the last decade to predict transport demand, includes the improvement in the estimation of the discrete choice models (Gutiérrez & Cantillo, 2014; McFadden & Train, 2000; Train, 2009). The theoretical background of this kind of models had its support in the random utility theory (Domencich & McFadden, 1975) which postulate that a person *n* faces a *J* set of alternatives and associates to each alternative *i* and an utility *Uin*, choosing the one that maximizes that utility. In the case of transportation mode choice the alternatives represent each mode, and the attributes are characteristics of the alternatives such as time and cost.

The *Uin* utility is represented in two terms: first, the part that the modeler can explain named *Vin* representative utility, and second, an error term *ein* associated with each alternative, that represents the part of the utility that the modeler does not know. The *Vin* utility is represented by the unknown parameters *qi* and the characteristics of the attributes of each mode *Xin* (Ortúzar & Willumsen, 2011):

$$U_{in} = \theta_i X_{in} + \varepsilon_{in} \qquad (1)$$

The typical procedure to estimate the discrete choice model is maximum simulated likelihood, and depending on the treatment of the error component, we can capture the random heterogeneity in the model (Train, 2009).

In classic choice models the decision-making is based only on the attributes of the alternatives and some socioeconomic characteristics in the sample (Ortúzar & Willumsen, 2011). However, recent work highlighted the importance of the psychological factors in the choice decision and invites to incorporate it for better explanatory power (Córdoba & Jaramillo, 2012; Hauster &

Koppelman, 1979; Paulssen, Temme, Vij, & Walker, 2014).

The Multinomial Logit Model (MNL) is the simplest and most popular practical discrete choice model (Ortúzar & Willumsen, 2011). This kind of model can be generated assuming that the random residuals are distributed IID Gumbel (also called Weibull). With this assumption the choice probabilities are:

$$Piq = \frac{exp\left(\beta V_{iq}\right)}{\Sigma A_j \varepsilon A(q) exp\left(\beta V_{jq}\right)} \qquad (2)$$

Where the utility functions usually have the linear in the parameters form and the parameter β (which is normalized to one in practice as it cannot be estimated separately from the θ) is related to the common standard deviation of the EV1 variate by:

$$\beta = \pi / \sigma \sqrt{\delta} \qquad (3)$$

3. Methodology

3.1. Dataset

Some stated preferences (SP) and revealed preferences (RP) experiments were conducted on students and employees living within 3 km of radius near the university campus in the city of Barranquilla, including three high education institutions: Universidad de la Costa, Universidad Simón Bolívar and Corporación Universitaria Latinoamericana. It is necessary to highlight that this distance was considered coherent for cycling displacements, given the climate of the city, as well as the lack of road infrastructure for cyclists, the lack of local policies that regulate this type of traffic and the non-availability of tools that promote the use of the bicycle in Barranquilla.

The goal is to analyze the demand for the use of bicycle for daily trips to the university, to study or to work. The survey contained four sections related to socioeconomic information, the RP questionnaire, the SP experiment with nine choice situations (Rose, Bliemer, Hensher, & Collins, 2008) and the position towards some variables about the use of bicycle within the city.

The first section of the survey included questions related to age, gender, marital status, socioeconomic stratum, study level, occupation and income. For modeling purpose the variables gender, age, marital status and stratum were treated as dummy variables, so: 1 for younger people (less than 40 years) and 0 for other cases, 1 for female 0 for male, 1 for single and 0 for other cases, 1 for high stratum and 0 for the others.

In the next part respondents were asked about the RP, namely the information of their last daily trip: the available transport alternatives, the chosen mode and the attributes of each mode: walking time (minutes), wait time (minutes), travel time (minutes), cost (Colombian pesos) and transfers (numbers and modes).

The third section is the SP experiment where respondents had to choose between bus and bicycle in nine hypothetical situations. The attributes we considered in this SP experiment were defined as follows: travel time, access time, cost and occupation, for bus. For bicycle, travel time, presence of cycle-lane, presence of showers and bicycle parking cost.

In the experiment design, all the attributes were treated in three variation levels, except the presence of bikeways and showers. Bus cost had average values of fare for public transport at the moment of the survey application, and the times were calculated for each mode depending on its average speed on a trip of less than 3 kilometers, the average speed was 30, and 10

km/h for bus and bicycle, respectively. Finally, cycle-lane and bicycle parking were dummy variables, where 1 represented the existence and 0 other case.

For the simplicity on how to answer the survey, we decided to use a choice experiment (Ortúzar & Garrido, 1994). Based on the levels and the number of attributes, we used a fractional factorial design with four blocks, each block with nine options (Rose, Bliemer, Hensher & Collins, 2008). To define the choice sets, we used the method of utility balance suggested by Huber & Zwerina (1996), and the construction of all the experiment implied the utilization of swapping levels and relabeling (Hensher, Louviere, & Swait, 1998; Hensher, 2006; Sandor & Wedel, 2001).

In the fourth and last section, we asked about the position towards some variables like bicycle use in the city, where the individuals had to rate it on a five-point scale, in which 1 is strongly disagree and 5 is totally agree. The questioned variables were: Trend, security (robbery and accident probability), saving, stress, weather, environmental sustainability, comfort, riders attitude, and some other ones.

3.2. Model estimation

A multinomial logit model (MNL) was estimated for the simulation of the individual´s decisions towards two different transport modes and to analyze the perceptions that can affect these choices (Bahamonde-Birke & Ortúzar, 2012). During the formulation and estimation process more than 20 models were designed with different utility specifications. Finally, we chose the model that exhibited better microeconomic and statistics consistency, for the two modes (bus and bike):

$$UBus = Cost1 + \theta ttime \bullet TravelTime1 \quad (6)$$

$$UBike = \theta + \theta cost \bullet Cost2 + \theta ttime \bullet TravelTime2 + \theta cycle \bullet CycleLane + \theta show \bullet Shower + \theta cygen \bullet CycleGen + \theta ttstrat \bullet TTimeStratum \quad (7)$$

According to socioeconomic variables, systematic variations in tastes are defined as follows:

$$TravelTime1 = Travel\ Time + Access\ Time \quad (8)$$

$$CycleGen = Cycle\text{-}Lane * Gender \quad (9)$$

$$TTimeStratum = TravelTime2 * High\ Stratum \quad (10)$$

Where:

- *Cost*, it is the rate that is paid to access to the mode of transport (for the case of the bus) or to use a secure parking (for the case of the bicycle).
- *Travel Time*, it is the duration of the trip, from the moment the individual leaves his home, until he arrives at the University. It includes the waiting time, access time and travel time inside the vehicle. Two different travel time parameters are estimated, the travel time by bus and the travel time by bicycle.
- *CycleLane*, it is a road within the city of exclusive service for the transit of bicycles. It is treated as a dummy variable that takes the value of 1 when it is available and 0 otherwise.
- *Shower*, it refers to the existence of bathrooms with showers and lockers inside the university campus. It was also set as a dummy variable that takes the value of 1 when it is available and 0 otherwise.
- *Gender*, it corresponds to the gender of the respondent. This is also treated as a dummy variable, which takes the value of 1 when it is female and 0 male.
- *Stratum*, it refers to the socioeconomic stratum in which the respondent resides. It is also considered as a dummy variable, setting the value of 1 for high stratum and 0 for the rest (medium and low strata).

4. Results

According to the model described earlier, two perception indicators were studied, seeing the influence these variables had on the choice mode. These are, the presence of cycle-line resulted more relevant for women at the choice time. Similarly, the travel time is more significant in the individual perceptions for people who live in high socioeconomic strata than people in low strata. As regards the other socioeconomic variables, such as marital status, age and incomes, indicators with a strong importance were not appreciated.

Table 1 shows each one of the parameters estimated in the MNL model, the t-test in parenthesis for significance. In all cases the signs were consistent with the microeconomic theory (Ortúzar S. & Willumsen, 2011):

Attribute	Parameter (test-t)
ASCBus	Fixed
ASCBici	-0.673 (-5.11)
βc (Cost)	-0.000473 (-5.64)
βcl (Cycle Lane)	1.35 (12.90)
βs (Shower)	0.195 (2.36)
βt (Travel time)	-0.0114 (-1.74)
βcg (Cycle Lane-Gender)	-0.213 (-1.74)
βts (Travel time-Stratum)	-0.0259 (-4.87)
Number of parameters	7
Number of observations	2893
Log-likelihood	-1.779.606
Rho-square	0.113

Table 1 . Estimation of relevant attributes in the MNL model

Travel time and cost are attributes that can cause disutility to the individual, then they are expected to have a negative sign. Meanwhile, the existence of cycle-lane and showers positively affects the utility with a positive sign in the parameter estimation.

Cost parameter has a high significance in this model, so the mode choice is influenced by the value that people must pay for the bus fare or the bicycle parking cost. On the other hand, cycle-lane existence with a 12,90 t-test value, shows the high significance of this parameter, remaining important at the time of the choice of the bicycle to go to study or work.

In a similar manner, the existence of showers presents an important significance value (2,36 t-test) and although it is lower than the previous parameter, is an influential factor in these choice modes. Although the existence of this type of infrastructure would require more time

spent by these people in terms of showering and changing their clothes, they would be willing to spend a few minutes preparing to get ready to study or to work in cleaner and cooler conditions.

5. Conclusions

We estimated a MNL model that defines perceptions indicators and socioeconomic attributes. The model was estimated using real data, results from the application of a survey to students and employees of three Universities in the city of Barranquilla, for trips between 3 kilometers near the campus. The survey aimed to analyze the reasons why people do not use the bike in the city to go to the study or work places.

The analysis indicates that students and employees would use the bicycle more if they could bank on exclusive lanes in their routes for their bikes and had showers with lockers in these campuses. Furthermore, the bicycle choice depends not only on the travel time and cost, but also on stratum and gender.

The gender and the stratum wherein people live, are socioeconomic attributes that affect the individual decision, women feel safer bicycling within a Bikeway than men, and people who live in higher strata consider travel time more important than the other ones.

Finally it could be demonstrated that people with the same socio-economic characteristics and the same available alternatives to mobilize, can choose different modes of transport, and their decisions can be influenced by their perceptions.

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