Comparative analysis of factors affecting the cyclists´ route choice

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ABSTRACT: The purpose of this article is to discuss the main factors that influence cyclists´ route in a Brazilian medium-sized city. Data for the analysis were obtained by means of questionnaires applied to a sample of cyclists. Respondents were asked about their personal characteristics (gender and age), travel behavior (frequency and experience with cycling) and the importance of several factors for their route choice. The rank of importance obtained from the analysis was compared to the results found in the literature and also with another survey conducted in the Brazilian context. The results of this survey may be used to subsidize the planning of sustainable urban transport systems, and may provide guidance to the allocation of resources in building cycling infrastructure. Finally, the definition of what constitutes a preferential environment for cyclists is emphasized, as it can help the urban planners to preserve, restore or create environments that attract more users to this sustainable mode of transport, making it viable for the daily trips.

Keywords *cycling routes; bicycle planning; cycling networks.*

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1. INTRODUCTION

All over the world, the bicycle is becoming an important option of transport mode, due to the ever worsening traffic conditions. Also, the growing concern about the harmful effects of environmental pollution and a sedentary lifestyle, contribute to increase the number of cyclists in cities.

This also happens in Brazil but, in many Brazilian cities, cycling infrastructure is absent or insufficient. Therefore, it is necessary to invest in providing the emergent demand for cycling trips with adequate infrastructure.

Information about the route choice behaviour is essential for the definition of functional cycling networks that meet the desire lines (direct connections between the points of origin and destination) of the users. In order to define which routes would be more attractive to cyclists, it is necessary to know the factors that influence their route choice (Segadilha & Sanches, 2014).

In this context, this paper presents the results of a survey carried out with a sample of cyclists in a Brazilian medium-sized city, in order to identify the main factors that determine their option for a route.

2. FACTORS THAT INFLUENCE CYCLISTS´ ROUTE CHOICE

Several attributes and user characteristics that influence the route choice can be identified in the scientific literature (Menghini et al. 2010). Comparing the chosen route to the ones that were not chosen is a recurrent strategy used by researchers in order to gather information on route preferences that could be useful for cycling planning (Aultman-Hall, Hall & Baetz, 2007).

The main factors that influence the cyclist route choice can be grouped into five categories, as shown in Table 1.

Table 1 - Summary of literature review about the factors that influence the cyclists´ route choice

FACTOR	REFERENCES
PHYSICAL CHARACTERISTICS	
Cycling infrastructure	Abraham et al. (2002); Moudon et al. (2005); Stinson & Bhat (2003, 2005); Krizek (2006); Krizek, El-Geneidy & Thompson (2007); Sener, Eluru & Bhat (2008); Broach, Gliebe & Dill (2009); Menghini et al. (2010); Winters et al. (2010); Larsen & El-Geneidy (2011); Caulfield, Brick & Mccarthy (2012); Li et al. (2012); Krenn, Oja & Titze (2014); Zhao (2014);
Topography (slopes)	Stinson & Bhat (2003, 2005); Sener, Eluru & Bhat (2009); Menghini et al. (2010); Hood, Sall & Charlton (2011); Broach, Dill & Gliebe

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FACTOR	REFERENCES
	(2012); Rondinella, Fernández-Heredia & Monzón (2012); Koh & Wong (2013); Krenn, Oja & Titze (2014);
On-street parking	Stinson & Bhat (2003, 2004); Krizek (2006); Tilahun, Levinson & Krizek (2007); Sener, Eluru & Bhat (2008, 2009); Menghini et al. (2010);
Pavement (type and conservation)	Stinson & Bhat (2004); Aultman-Hall, Hall & Baetz (2007);
Barriers / obstacles	Stinson &Bhat (2005); Emond & Handy (2012);
TRAFFIC CHARACTERISTICS	
Stop signs	Fajans & Curry (2001); Casello, Rewa & Nour (2012); Stinson & Bhat (2003); Aultman-Hall, Hall & Baetz (2007); Papinski, Scott & Doherty (2009); Sener, Eluru & Bhat (2009); Menghini et al. (2010); Winters et al. (2010); Broach, Dill & Gliebe (2012); Caulfield, Brick & McCarthy (2012); Krenn, Oja & Titze (2014); Zhao (2014);
Speed and volume of traffic	Aultman-Hall, Hall & Baetz (2007); El-Geneidy, Krizek & Iacono (2007); Hunt & Abraham (2007); Sener, Eluru & Bhat (2009); Winters et al. (2010); Broach, Gliebe & Dill (2009, 2011); Caulfield, Brick & McCarthy (2012); Segadilha & Sanches (2014b);
Traffic composition	Sener, Eluru & Bhat (2009); Broach, Dill & Gliebe (2012); Menghini et al. (2010); Winters et al. (2010);
Number of street lanes	Shankwiler (2006); Hyodo, Suzuki & Takahashi (2000);
Road hierarchy	Abraham et al. (2002); Aultman-Hall, Hall & Baetz (2007); Winters et al. (2010); Koh & Wong (2013);
ENVIRONMENTAL CHARACTERISTICS	
Trees (shade)	Winters et al. (2010); Krenn, Oja & Titze (2014);
Lighting	Menghini et al. (2010);
Land use	Stinson & Bhat (2003); Winters et al. (2010); Lee, Jennings & El-Geneidy (2011); Koh & Wong (2013);
TRIP CHARACTERISTICS	
Time/duration	Stinson & Bhat (2003, 2005); Papinski, Scott & Doherty (2009); Sener, Eluru & Bhat (2009); Menghini et al. (2010); Hood, Sall & Charlton (2011); Caulfield, Brick & McCarthy (2012); Yang & Mesbah (2013);

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FACTOR	REFERENCES
Lenght/distance	Abraham et al. (2002); Casello, Rewa & Nour (2012); Dickinson et al. (2003); Aultman-Hall, Hall & Baetz (2007); Menghini et al. (2010); Winters et al. (2010); Broach, Gliebe & Dill (2011); Heinen, Maat & Wee (2011); Yang & Mesbah (2013); Beheshtitabar et al. (2014); Krenn, Oja & Titze (2014);
CYCLIST CHARACTERISTICS	
Gender	Dickinson et al. (2003); Krizek, Johnson & Tilahun (2004); Aultman-Hall, Hall & Baetz (2007); Dill & Gliebe (2008); Sener, Eluru & Bhat (2009); Rondinella, Fernández-Heredia & Monzón (2012);
Experience	Stinson & Bhat (2005); El-Geneidy, Krizek & Iacono (2007); Hunt & Abraham (2007); Dill & Gliebe (2008); Sener, Eluru & Bhat (2009); Winters et al. (2010); Larsen & El-Geneidy (2011);
Age	Bernhoft & Carstensen (2008)
Perception of security	Dickinson et al. (2003); Krizek, Johnson & Tilahun (2004); Tilahun, Levinson & Krizek (2007); Harvey, Krizek & Collins (2008); Sener, Eluru & Bhat (2008, 2009); Dill (2009); Kang & Fricker (2013); Koh & Wong (2013); Zhao (2014);

From the literature review, it could be inferred that, predominantly, cyclists prefer routes with continuous cycling infrastructure, absence of parallel parking, low volumes of traffic, low speeds, fast and short paths.

The experienced cyclists feel comfortable riding in shared traffic and are relatively indifferent to the type of cycling infrastructure. These cyclists prefer routes that minimize travel time and reduce delays.

In general, the trips made by men and women have different characteristics. For example, the number of bicycle trips made by men in the United States, outnumber the trips made by women on a ratio of, at least, two to one. The gender-related differences are also expressed in the average length of travel, with men traveling longer distances.

There is, in general, a preference for flat routes (or the ones with moderate slopes), with few mandatory stop points (like traffic lights, intersections, stop signs, roundabouts, etc.).

3. METHODOLOGY

Data for the analysis were obtained by means of stated preference, in which some questionnaires were applied to a sample of cyclists who use the bicycle for most of their utilitarian travels. The cyclists were found, mostly, in places with bike parking rack.

Respondents were asked about their personal characteristics (gender and age), travel behavior (frequency and experience with cycling) and the importance of several factors for their route choice

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20 factors that may influence route choice were included in the questionnaire. The respondents were asked to evaluate each factor in a five-point semantic differential scale: (1) Totally unimportant (2) Not very important, (3) Indifferent, (4) Important and (5) Very Important.

4. RESULTS

The survey was carried in São Carlos-SP, a medium-sized city, with around 240 thousand inhabitants (IBGE, 2016). According to an Origin-Destination survey held in 2008, only 3% of the trips are made by bicycle in the city.

Table 2 presents the respondents´ profile, with the general characteristics of the 30 cyclists who participated in the survey. The sample consists predominantly of men (above 80%) aging between 18 and 25 (more than 50%).

Table 2 – Cyclists profile

GENDER		AGE GROUP	
Male	83,3%	< 18 years	0,0%
Female	16,7%	18 to 25 years	53,3%
		26 to 35 years	26,7%
		36 to 45 years	13,3%
		> 45 years	6,7%

Table 3 shows that the respondents were experienced cyclists who ride the bicycle frequently.

Table 3 – Travel behavior of the cyclists

CYCLING EXPERIENCE		FREQUENCY OF BICYCLE USE	
Less than 3 months	0%	1 to 3 times a week	10%
3 to 6 months	10%	More than 3 times a week	90%
6 months to 2 years	20%		
2 to 5 years	30%		
More than 5 years	40%		

Table 4 shows the importance level of the 20 aforementioned factors that influence in the cyclists' route choice. The larger the average more important is the factor.

Table 4 – Importance of the factors

FACTOR	AVERAGE	FACTOR	AVERAGE
Shortest path	4,2	Number of street lanes	3,5
Volume of vehicles	4,1	Need to cross obstacles	3,5

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FACTOR	AVERAGE	FACTOR	AVERAGE
Travel time	4,0	Unevenness along the curb	3,4
Conservation of the pavement	4,0	Trees (shadow)	3,3
Slope (hills and slopes)	3,9	Average speed on the road	3,3
Existence of bike paths or lanes	3,9	One way roads	3,2
Security (crime)	3,8	Permission for parking on the right side of the road	3,1
Type of pavement	3,8	Having to go through roundabouts	3,1
Lighting (in the evening)	3,6	Number of intersections with mandatory stop	3,0
Bus and truck traffic	3,6	Presence of bus stops	3,0

The following factors were identified as the four most important: shortest path, volume of vehicles, travel time and conservation of the pavement.

5. DISCUSSION

Among the four most important factors, the volume of vehicles is consistent with the results found by Segadilha & Sanches (2014). In a similar survey, also applied in the city of São Carlos-SP, the authors found that the number of trucks and buses, and the volume and speed of traffic were the most important factors for the route choice.

Still about the conclusions of the abovementioned authors, they have found that slope is considered the lesser importance factor. The results of the present survey, on the other hand, points out to the presence of bus stop points and the number of intersections with mandatory stop as the least important factors.

The outcomes of the present survey are consistent with the international scientific literature, that points out to the shortest path as the main factor in the route choice. It is important to mention that Segadilha and Sanches (2014) did not consider the shortest path as an option in their questionnaire; wich explains some discrepancy in the results.

6. FINAL CONSIDERATIONS

Although the sample of cyclists (30) it is very limited, being only preliminary results, they may be used as a first step to subsidize the planning of sustainable urban transport systems, and provide guidance to the allocation of resources in building cycling infrastructure.

Even though the brazilian reality can be different in some elements, it is important to use this results in consonance with that was found in the literature review, since some aspects are equivalent.

Finally, the definition of what constitutes a preferential environment for cyclists is emphasized, as it can help the urban planners to preserve, restore or create environments that attract more users to this sustainable mode of transport, making it viable for the daily trips.

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