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RESEARCH ARTICLE

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CYCLIST´S PERCEPTION OF SERVICE QUALITY AS A TOOL FOR BIKE PATH PROJECTS EVALUATION

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ABSTRACT

Bicycle projects in Brazil tend to follow technical recommendations, but most devoid inqueries to the cyclists, on perceptions about their needs. The study aimed to discuss the importance of perception on service quality by cyclists, as a tool for bicycle path projects evaluation; so that they have the functionality and safety expected by users. The method is empirical, with interviews to the cyclists, to identify their profiles and quality of service factors, followed by analysis of results, with characterization of cyclists, the main factors of service quality and comparison to technical characteristics of projects in relation to standards. The interviews results were compared with technical standards recommendations to Brazil projects. Among the results obtained in a case study, the aspects of signaling, pavement conservation *status* and the need for vehicular velocity reducers, as inhibitors of bike paths use, were evidenced; and for reasons that can be solved with the improvement or adjustments of road projects and revision of technical standards.

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INTRODUCTION

In most large urban centers, non-motorized transport users have difficulty in accessing to road system, which has become a space of frequent dispute and conflict (Vandenbulcke *et al.,* 2009). Studies in the scientific literature support a view that the city can expand, resulting in pressure on preservation areas and, the deployment costs of infrastructure necessary to support the current mobility model, centered on private vehices are disregarded; whose negative effects and circulation costs are socialized (Heinen and Van Wee, 2010). Cycling projects in Brazil, usually, follow technical standards recommendations, however, inqueries with cyclists about their perceptions and experience in urban environment, still at the design stage, are often neglected. Thus, this work had been focused on cyclists perception about service quality in cycling projects, in face of technical standards, and how this information can contribute to the projects improvements and to promote the bicycle use in urban spaces. The premise validation was consolidated with a case study in an important bike path in Belem, Brazil, with cyclists interviews and data survey of geometric and traffic characteristics, presenting several observations on the bike path already implemented project and, if they are consistent or not with technical standards recommendations in Brazil.

BACKGROUND

As a basic principle in assessing perception, it is important to understand that each human being has a particular view of the world. For Karsaklian (2000), perception will be subjective, selective, simplifying, time-limited and cumulative, which makes perception something that is made of what is seen, something of interest to those who perceive it, in addition to adding a cognitive value. *Stimuli* are received through the senses and decoded by the central nervous system, turning into perception, which is a process decomposed into two distinct phases: sensation and interpretation. The definition of transport service quality followed the definition by Parasuraman *et al.* (1985), being the users perceptions on transport service resulting from an performance evaluation of service attributes, due to the experience of interactions occuring between users and transport mode in service production process. Regarding the service image and design aspects, more directly involved, a way of measuring the degree of user satisfaction in relation to these aspects, especially, those related to personal safety and comfort issues, is the use of psychometrics scales, in which interviewees answer to a questionnaire expressing their level of agreement with a statement. The most widespread in scientific literature is the Likert (1932), used to measure attitudes and to know the interviewee's degree of compliance with any proposed statement. Measuring the quality of service in cycling projects is a concern that dates back to the 1960s, with the consolidation of these studies in Highway Capacity Manual (TRB, 1985), in which a chapter on bicycles was published, focusing on flow effects of bicycles in intersections traffic. One of the first consistent attempt to measure the road level of service for cyclists was made by Davis (1987), who assigned service level indexes, based on factors and physical characteristics. In the 1990s, stand out studies involving safety factors in Dixon (1996), Landis *et al.* (1997) and BCI (FHWA,1998) and, also on issues of safety and pavement in Epperson (1994) and Eddy (1996). In the 2000s and 2010s, studies advanced and, in terms of comfort, as in Ehrgott *et al.* (2012) and Furth and Mekuria (2013), also involving signaling and security, such as the HCM (TRB, 2010). In terms of practical experiences of implementing cycling projects, there are cities such as Amsterdam (Dutch Bicycling Council, 2006) and Copenhagen (Gehl, 2010). In Brazil, several studies were developed, highlighting Providelo and Sanches (2011), and Magalhães and Palhares (2013), with variables that influence the choice of cycling mode for urban trips. More current studies approach behavioral character in bicycle preference (Souza, 2012), advancing in methodology for identifying networks of cycling routes and definition of indicators for road segments assessment (Magalhães et al., 2015; Cardoso and Campos, 2016). The evaluation method used is essentially based on reference studies in Brazil, with emphasis on the Bicycle Brazil Program (Ministry of Cities, 2007), with a *checklist* of service quality factors identified as the most important, resulting in three groups of general factors to be evaluated by cyclists (Chart 1). Data collection included prior survey of bike path design characteristics: geometric measurements, for comparison purposes with technical standards; environmental, as interference by construction elements or afforestation and traffic; in addition to opportunities due to location; and, finally, application of a questionnaire to determine the characteristics and perception inherent to cyclists, on features: socioeconomics and perceived quality of service about cycle project implemented, to the case study; of which they are users. On service quality assessment, physical characteristics of projects and traffic were explored, assuming the bike path functionality degree for those users, given their personal characteristics and preferences. To assess the image of service, the likert scale has been used, presenting statements to the cyclist about the service level of bike path, involving factors as presented in Chart 1. Thus, it could be assessed the degree of compliance and/or satisfaction with the project and, in case of negative perception about any factor, suggestions for project improvements of project were made. The analysis of service level attributes was based on the premise that the higher value attributed (weight) to a claim, greater the importance of the attribute related to it. There are several divisions of Likert scale and, in this work, the qualitative statements proposed were from 1 to 5, as shown in Table 1. The responses were assigned weights of 1, 2, 0, 3 and 4, assuming a neutral point and a two-dimensional character of scale. That is, a neutral point in the center (for undecided or no-opinion type) and on the sides, bipolar responses: 3 and 4, partially agree and fully agree, respectively. And for values 1 and 2, “I partially disagree” and “I fully disagree”, respectively. Interviews results had statistical treatment with weighted average calculation from responses to the various degrees of agreement/disagreement. In sequence, the user satisfaction level was classified according to the mathematical weighted average range in Table 1. It is important to note that, depending on the case, some of variables in Table 1 were present or not. Furthermore, it is suitable to observe that the method is able to refine cyclists perception about projects elements, in order to compare with technical standards recommendations used in cycling projects in Brazil, in order to point out design improvements.

RESULTS

For the case study, the bike path on Almirante Barroso Avenue, in Belem, Brazil was chosen. It has almost six kilometers long, located at the main entrance of the city, which has a population of 1.4 million inhabitants (IBGE, 2010). In Figure 1, there is an avenue cross-sectional profile image, showing all the lane divisions by type of use, where the cycle path is present on central flowerbed. Note the two types of geometric profiles images: the most prominent, one is predominant along the entire stretch and, in minor hightlight, the second image, the part where it is behind the BRT stations, considered the most critical point of project dimensions, ranging from 2.2 m and 2.5 m.

Project physical characteristics: this cycle path runs through the central flowerbed, along a public transport corridor, well signalized, dividing the space with Bus Rapid Transit (BRT) stations. It is bidirectional, with a great cyclists demand from different origins in the city, sharing the space with neighboring cities travels to various destinations. Along the road, there are nine intersections, with crossings protected by vehicular traffic lights. There are no paracycles or bike racks, with bike racks expected at BRT stations. Geometric measurements of bike path design are described in Table 2, given in terms of minimum and maximum measurements; observing that bike path has some irregularities in its route. According to the data in Tables 1 and 2, the bike path has dimensions that practically fit the recommended parameters, except for the lane width, which is reduced to make room for other obstacles such as BRT stations and lighting poles. The landscaping that exists along the bike path is noteworthy, with trees planted in rows between the tracks, making the space more pleasant. Table 3 shows a comparison with technical recommendations of GEIPOT (2001) and the Ministry of Cities (2007).

Urban location factors: most of Belem bus lines are concentrated in this corridor, and it also partially receives cargo transport, from various destinations in a radial or diametrical manner. Due to this characteristic, it is a corridor with a large volume of mixed traffic, with frequent interaction between local traffic and through traffic, compulsory, at least in intersections with traffic lights. In the volumetric count carried out, during an interval of one hour within the peak period, for a certain stretch, in the central cycle path, it can be verified that bicycle traffic is already approaching 10% of total volume of traffic (Table 4). It was observed very similar situations of bicycle traffic density along the corridor (in the other stretches). Vehicular traffic situation is dominated by presence of cars, followed by buses, which makes the traffic situation very unfavorable for cyclists, with increase risk of accidents. Bicycles volumes obtained in the bike path under study are similar to the bike paths of most Brazilian cities, with same geometric and location characteristics (Ministry of Cities, 2007). It is noted that more than 50% traffic flow are cars, which emphasing the need to make apart vehicles and cyclists. The average speed of cars (on board) and bicycles (pedaling) on this same stretch of bike path was measured, under normal road and traffic conditions, at the same peak hour. See Table 5. The maximum speed allowed at Almirante Barroso Ave is 50 km/h, that is, the average speeds obtained are very close, in which it can be inferred that at least 50% of motor vehicles circulate above the maximum speed allowed on the track.

Cyclists characteristics and perception: the survey took place at the peak of 5 pm to 6 pm, and 100 cyclists were interviewed, with random selection, assuming the normal probability for the sample of cyclists, as representatives of users universe. Among personal characteristics: income, age, gender, education level. Challenges faced by cyclists on the bike path were observed, for each aspect: regarding the quality and conservation of the pavement; the risk of accident; the distance between the bike path and BRT railing, which even in according to tecnhical recommedations, could bring a feeling of insecurity to the cyclist and, also regarding the speed of buses in BRT lane.

Chart 1. Service Quality Factors - groups

	Fatores	Variáveis
Group 1	Project´s physical characteristics	Width of bike path in meters; Pavement quality (no cracks, bumps or tree roots); Obstacles such as power poles, signs, trees, vehicles parked on the bike path, stairs and unevenness; exclusive opportunities to go through walkways, tunnels, viaducts, signaled pavement and traffic lights for cyclists, parking.
Group 2	Bike path urban location	Availability of access to different routes in the city, between origins and destinations, and proximity to public transport; environmental quality of shading path; conflicts intensity with other modes of transport; entry and exit of vehicles along the route; crossings at intersections with a large traffic volume, causing air and noise pollution.
Group 3	Cyclist´s inherent characteristics	Personal characteristics of preference linked to personal experiences, age, gender and occupation; personal safety, as a qualitative measure of degree to which the path is safe for users, including adequate lighting; presence of regularity in the route pavement; path visibility seen at a distance and continuity of the route.

Table 1. Attribute Analysis - parameters and weights

Statements	Weights	Weighted Average	Service Level
5. Fully agree	4	3.00 to 4.00	Excellent (Fully satisfied)
4. Partially agree	3	2.00 to 2.99	Good or Regular (Partially satisfied)
3. Undecided or no-opinion	0		
2. Partially desagree	2	1.00 to 1.99	Poor or very poor (unsatisfied)
1. Fully desagree	1		

Table 2. Bike path´s geometric measurements

Dados	
1 track/one direction	1.04 m to 1.45 m width
2 tracsk/ two directions	2.08 m to 2.90 m width
Track thickness	10 cm height
Embankment	20 cm height
Central flowerbed	0.75 m to 1.4 m width
Side railing	1.41m de height
Paviment unevenness	20 cm

Table 3. Bike path´s geometric measurements and technical standards – comparison

Minimum measurements				
	1 track	Embankment	Thickness	Side railing
GEIPOT (2001)	1.10 m	0.10 cm	0.10 cm	-
Ministério das Cidades (2007)	1.50 m	0.20 cm	0.10 cm	0.75 m
Almirante Barroso Ave bike path	1.04 m	0.20 cm	0.10 cm	1.41 m

Table 4. Vehicle volumetric counting and modal share (%)

Modes	Vehicles´volumes[1]		
	Downtown direction	Sentido BR 316 direction	Share modal (%)/Total
Bicycle	110	262	(9%)
Motocycles	284	476	(17%)
Automobiles	1040	1314	(55%)
Pickup trucks	76	80	(4%)
Common buses	236	240	(11%)
Trucks	26	16	(1%)
Express Buses[2]	44	54	(3%)
Total (vehic/h) on stretch	1,816	2,442	4,258

[1]Vehicles´volumes on Almirante Barroso Ave, between 5:00 pm and 6:00 pm, within the peak period, between Dr. Freitas Ave and Lomas Valentina St. [2]Express: buses on BRT lane.

Table 5. Average speed of vehicles (automobiles and bicycles)

Mode	Travel time, min	D-P direction[1]	P-D direction[2]
		Downtown, km/h	BR 316, Km/h
Bicycle, P-D	18	33	-
Bicycle, D-P	20	-	30
Automobiles, P-D	13	46	-
Automobiles, D-P	15	-	40

[1]P-D, Periphery – Downtown direction. [2]D-P, Downtown – Periphery direction.

Table 6. Service level of attributes to Almte Barroso Ave bike path

Attributes	Weighted Average[3]	Service level
Accessibility	3.5	Excellent (Fully satisfied)
Information System	2.3	Good or Regular (Partially satisfied)
Travel time	2.5	
General satisfation	2.8	
Safety	1.5	Poor or very poor (unsatisfied)

[3]weighted averages´ rounded values

Source: Authors, 2019.

Figure 1. Almirante Barroso Ave bike path cross-sectional profile

In the inqueries, issues of personal safety and comfort were made as statements, to measure the level of service on Almirante Barroso Ave bike path, using the Likert scale consisting of five items linked to Table 1, which evaluated service level attributes: accessibility (location and connections between origin and destination – Group 2); safety (traffic interactions, crossing conflicts, physical design aspects – Group 1 and Group 3); travel time (obstacles in progress – Group 2); information system (signage – Group 1) and general satisfaction with the cycle path project (Group 3). On the bike path under question, the objective was to explore some factors of service quality, since the case didn´t offer conditions to explore all Table 1 variables, but the selected items, certainly, allowed the results assessment that met the objectives of this work. Thus, for the selected service quality factors, the cyclists were asked about the level of satisfaction, in terms of statements about these factors, indicating the level of service, assigning respectives weights. Table 6 shows service level atributes results on bike path in Almirante Barroso Ave, presenting the parameters and weights. For example, for accessibility item, linked to group 2 of Table 1, it was presented the following statement to the cyclist for evaluation: "Almirante Barroso Ave bike path is well located and allows connections to several and important destinations in the city and metropolitan region". In the questionnaire there was space for scoring weights of 1, 2, 0, 3 and 4 (see Table 1). From the set of responses of cyclists and the respective weights assigned to each item, the weighted average in the responses for all items (or attributes) was calculated, and shown in Table 6.

DISCUSSION

The selection of cyclists on the road was random, with cyclists aged 15 years and over. For this bike path it was possible to find that 80% of cyclists earn up to two minimum wages and are male; 16% from 15 to 25 years old; 45% from 26 to 37 years old and 32% from 38 to 49 years old. Only 7% over 50 years old. In education, 70% are doing or have completed high school and 62% are salaried, that is, included in the formal labor market. In the spontaneous response, regarding the challenges faced by cyclists on the bike path, cumulatively, there are citations for each aspect: 87% complained about the poor condition of the pavement; 77% about the risk of accident (an aggravating factor is the BRT railing that runs parallel to the bike path); 43% criticized BRT lane width and, 42% the low railing which, even being above the recommended, brings a feeling of insecurity to the cyclist. In fifth place, 35%, the buses speed in BRT lane. Personal and socioeconomic characteristics of cyclists appear to towards a predominant layer of people in the economically active phase, with more than 60% of salaried workers; which denotes the importance of this bike path for workers in formal market in the Belem Metropolitan Region. Survey, also showed frequent and young cyclits, who use the bicycle daily for their tasks. On the other hand, it is statistically admitted that service level results, probably, have the bias of preferences and experiences from this working mass, given the representativeness of the sample. The level of accessibility satisfaction was measured by the connections between origin and destination (see service levels assigned in Table 6). On satisfation, 82% are fully satisfied with bike path direct, by connection to the desired destinations, as well as, the fact that it offers possibility of integration to other bike paths and bike lanes in the city and with public transport. On security, it was measured by traffic interactions, conflicts with through traffic, physical design aspects, and the result indicated that overall users are not satisfied, in 73% of responses. Among the most cited factors, cyclists feel unsafety in relation to accidents, as well as, in public insurance, due to the increase in crime. Although urban violence is a problem outside the scope of transport system, this ends up reflecting on users relationship, which in this factor exceeded 85% of unsatisfaction. Regarding the project, the cyclists complained about pavement irregularities (65%) and on lanes width, features that make it path unsafe (33%). In addition, the railing that separates BRT lane and bike path are close and still low, inhibiting the cyclist in the face of high-speed bus traffic in BRT lane (25%). The satisfaction level of travel time was measured, primarily, in terms of traffic conflicts and physical obstacles.

The result indicated that 85% of users are satisfied. However, 70% also pointed out design features that affect the cyclist's speed, as the lane width reduced to minimum widths and, in some stretches, problems with pavement cracks, besides to dodge trees, lampposts public and signs, which cause a longer delay in journeys. The bike path information system, basically, defined by signaling, was measured by satisfaction degree, showed more than 75% of users are satisfied with signaling along the bike path. The assessment was affected by the signaling complaint at crossings in intersections (34%), as the cyclist left the bike path to the sidewalk to change path. In general, cyclists are satisfied with the bike path (70%), just standing out in a negative way, the safety attribute as the main responsible for quality of service drop (65%). As project review recommendations were suggested: reduction of central flowerbed, in some stretches, to increase the width of bike path; full signaling for crossings at intersections, with markings in different colors on the floors, for route exit and crossing to the side of the road. Also, one has to think about traffic lights implementation for cyclists; bus traffic speed control implementation in BRT lane, to be more safety and to reduce the feeling of cyclists´ insecurity.

CONCLUSION

The initial objective was achieved in this work, through the case study employed was possible to point out relevant features of cycling projects, which have repressing bike path demand, for reasons that can be solved. In other words, perception proved to be valid as a design tool. Obviously, the technical recommendations cannot be waived, but it must be considered that the users' perception becomes fundamental for the knowledge of subjective aspects of behavior and sensations experienced in the act of pedaling. The current speed on the road has 50 km/h maximum allowed, combined with the design conditions of bike path, bring cyclists closer to the buses, and require the implementation of speed reducers to the vehicles, to give more safety and comfort to the cyclists. This should imply geometrical changes in bike path, along the entire lane, and a narrowing at the BRT stations. The Likert scale, as part of the perception evaluation method, proved to be adequate, with adherence to what was observed in the field, in interviews with cyclists and in the survey of project's physical characteristics and environmental interferences. Table 6 shows the scale of greatest complaints from cyclists, around the safety factors, such as the worst level of service feature. The best evaluated aspect was the accessibility, probably, due to the fact bike path is located in the main public transport corridor of city. The overall satisfaction level of bike path performance is close to weight 3, which denotes the cyclist partially satisfied. In conclusion, it was proven that the perception of the cyclist can be an efficient tool to the planning and management of cycling projects, as well as, the method used. For further studies, it is recommended to deepen this analysis, incorporating more attributes and carrying out the analytical exercise of studies segmented by characteristics inherent to the cyclist, for example, income, age, occupation or even reason for travel, as well as the degree of relevance of these attributes, to improve the projects according to their specific purposes, in compliance perspective of a target group of cyclists.

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