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MULTICRITERIA ANALYSIS FOR EVALUATION OF BIKE LANE ROUTES INTEGRATED TO PUBLIC TRANSPORTATION

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Abstract

The integration of the bicycle with the passenger public transportation is efficient to increase the sustainable urban mobility strategy and improves quality of life. The objective of this paper is the development of a method to assist in evaluating the "best" cycling route integrated to public transportation and to consider among other criteria, the factors of individual choice of cyclists. To validate the proposed method was used as case study Mussurunga Station, Salvador, Bahia, Brasil. The results showed that in the perception of the cyclist the main criteria that influence the choices of their paths are related to safety aspects.

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Keywords: Bicycle, modal integration, cyclist Perception, focus group, multi-criteria analysis.

1. Introduction

From the accelerated industrialization in Brazil, which had its starting point in 1950, there was the phenomenon of rural exodus and according to IBGE (2010), 84.36% of the population live in urban areas nowadays. This reality has caused, especially in large Brazilian cities, unplanned population growth, resulting in irregular housing in peripheral areas far away from the business centers. Among the problems with this unplanned urbanization, there has been increasing demand for transport with increasing need for commuting.

Within this context, unlike what is happening in developed countries like the Netherlands and France, which developed to encourage the use of public transportation and increasing ease to integrate bike policy, Brazil still maintains a policy of

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encouraging the automobile over the collective and non-motorized modes, resulting in an unsustainable mobility, with daily traffic, major traffic jams and consequent degradation of environmental conditions and public spaces.

Salvador, city chosen for the study of this work, is embedded in this reality. With a population of 3,642,682 inhabitants (IBGE 2010) corresponding to the third most populous city in Brazil, it has a transit almost always congested, public transportation service with low quality, which supply cannot meet the needs of population displacement. Facing this situation the Municipality of Salvador has developed an Integrated Transport Plan which proposed an Integrated Transport Network (RIT), with the deployment of two subway lines under construction, integrated with the bus mode. However, the integration of this network with non-motorized modes provides only the implementation of bicycle and bicycle racks without dealing with the paths that allow access for cyclists to the stations.

In Brazil, in the National Policy on Urban Mobility, there are some steps to get a sustainable city, they are: encouraging the use of public transportation, the priority of non-motorized transportation modes on motor, promoting sustainable development with mitigation of environmental and socioeconomic costs of displacement of people and cargo in cities, discouraging excessive use of the automobile, the integration between different modes of transportation, the integrated planning of land use and transportation and design of public spaces to encourage the use of non-motorized transportation (BRAZIL, 2012).

The article presented here is part of a research project developed by CNPq-Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq MCT/CNPQ Project 18/2009), entitled *Methodology for deploying Integrated Collective transport Cycling Network in Brazilian Cities*, whose aim was to establish a methodology for deploying integrated cycle network to public transportation in Brazilian cities. This project has the participation of three Brazilian metropolises and it has been developed by the Federal University of Pará (UFPA), Federal University of Bahia (UFBA) and Federal University of Pernambuco (UFPE).

The purpose of this article is the development of a method to assist in the evaluation of "best" cycling route integrated to public transportation that considers, among other criteria, the factors of individual choice of cyclists. It is divided into four sections: section 2 presents an overview of published works on the bike theme, while Section 3 deals with the methodological approach discussed in this work, also Section 4 presents a case study conducted in the city of Salvador, and section 5 presents the main conclusions.

2. Literature Review

There are several studies on the use of bicycles, especially those developed in foreign countries and few studies in Brazil on the bike theme.

Of the studies done in foreign countries, the main ones are:

In Texas - USA, Sener et. al. (2009) sought to identify and assess the importance of attributes that influence the choice of bicycle use and of cycle routes. Among these attributes stand out features of the cyclist, pathways and parking. The results of the study highlighted the importance of a comprehensive evaluation of attributes and data on cyclists to decide on the choice of cycle routes. The practical results indicate that the travel time and volume of motorized traffic are the most important attributes in choosing of cycle routes, as well as the amount of traffic signs, speed limits and characteristics of parking.

In a survey conducted in New Zealand, Tin Tin et. al. (2009) investigated the attitudes of 2,469 cyclists in relation to environmental policies and measures to encourage the use of bicycles for travel to work. This study concluded that the majority of respondents cyclists (88%) indicated the bike lane as an important infrastructure to increase bicycle use and 38% cited the encouragement of public bicycle rental systems. Those traveling by bike at least once a week to work cited a few points that encourage this use: increased fuel prices (41%), lower amount of parking for cars (27%), increasing the price of these car parks (25%).

In a survey developed by Su et.al.(2010) whose goal was the route planning to promote bicycle travel to the metro in Vancouver, Canada, a program of cycle routes was made using the Google Maps interface. This tool allowed the user to retrieve optimal routes for bicycle based on their own references. The use of this tool besides helping to promote cycling trips integrated to public transportation, it also contributed in reducing the number of car trips (2010).

In U.S.A, McLaughlin and Glang (2010) evaluated the effect of cycling on 206 elementary students through a computer program called Bike Smart. This software aims to teach safety behaviors for cyclist children. This research demonstrated that in addition to being low cost, the program was effective in training these children to safety.

In Holland, Heinen et. al, (2010) analyzed the influence of the attitudes of cyclists on the benefits of cycling as lower vehicle cost and benefits it brings to health. This work concluded that the habit of cycling increases the likelihood and frequency of

cycling and attitudes and other psychological factors have a strong impact on the choice of cycling.

In a survey conducted in 589 municipalities of Belgium confirmed a wide range of uses of cycling. It was observed that the main factor of using this mode is mainly related to environmental aspects. However, factors such as city size, distance and demographics were also important for the choice of using this mode. We also observed the existence of large regional differences as regards the impact of certain variables such as traffic volume and accidents involving cycling (Vandenbulcke et al. 2011).

In Brazil, Ribeiro (2005) and Aquino (2007) highlighted the potential of intermodal bicycle with transportation, although they do not include considerations in their studies on network access for bicycles to the station integration. Coelho (2010) has developed a survey that addressed the perception of cyclist on the risk in their paths, but was restricted to bike lanes, which were used for travel or leisure. Coelho's studies (2010) did not address the issue of integrating cycling with passengers public transportation.

Starting from the premise that the promotion of bicycling as a mode of transport includes adequate provision of infrastructures for the cyclist, Providelo and Sanches (2011) developed a research to be applied in medium-sized cities in Brazil where we determined some characteristics considered as priorities for cyclists and potential users of the bike. In this research it was found that the five most important attributes that should be considered to promote the use of bicycles in these cities are: lane width, speed of motorized vehicles, visibility at intersections, junctions and the presence of tree-lined streets.

Still in this line of research Providelo (2011) conducted a study for Brazilian midsize cities that addressed the perception of the rider with the level of service in shared paths, it was a proposition for mid-sized cities. In this study, the measure of level of service for bicycles was defined as the capacity of a road segment or intersection, to accommodate motorized vehicles and bicycles safely. The most frequently used to describe the compatibility or suitability of routes for the transport of bicycles attributes were: traffic volume, roadway width and speed of motorized vehicles. Other attributes were also identified and they can be added here and can be sorted by categories: traffic, infrastructure, environment and conflict.

Silveira and Maia (2012) published an article presenting an overview of the state of the art on the bike theme. This work was carried out based on a survey conducted in the Scopus database (which is a bibliographic database or source of international coverage of Elsevier), in the period from 2000 to 2011, all full text articles available that had any reference to the bicycle theme. Its main purpose was to point out the main lines of publications on the bike and aggregate academic information that can guide further research and policies that encourage the use of bicycles, collaborating with the implementation of measures for sustainable cities. In the considered period 399 papers were surveyed. These articles were, for methodological purpose, distributed in seven (7) categories according to their main goal. They are analysis and accident prevention, transportation, behavior, health, features and design, the environment and sport. As a result, it was found that most articles was focused on the analysis and prevention of accidents (41%), followed by articles classified under transport (24%). It was also observed that about 70% of the total surveyed articles deal with four types of issues: (i) traffic and reasons for displacement (32%), (ii) characteristics of cities and / or people to use as predictors to use the bike (15%), (iii) types of infrastructure geared for cycling (13%) and (iv) policies and programs that support bicycling (10%). The remaining 30% of articles in this category deal with diffused themes.

Based on the research entitled *Methodology for Implementation of the cycle network Integrated Public Transportation in Brazilian Metropolises* (Project CNPQ MCT / CNPq 18/2009), Ribeiro et al. (2012) published a paper that presented a comparative analysis of the results of three surveys conducted respectively in 2004, 2009 and 2011, in the city of Salvador, Bahia, Brazil, aiming at assessing the potential of integrating cycling with public transportation of the city (potential demand) and needs for this integration. The study concluded that there is a growing trend of willingness to integrate bicycle to public transportation (potential demand). However, both the public and road safety for these displacements are unsatisfactory, exposing cyclists to all kinds of risks. The lack of integration with public transportation and parking structured to guard the bike restricts people who know cycling not to use it regularly as a mode of transportation. Several factors identified in this study, mainly associated with the behavior of demand, enabled to reveal the existence of a large potential for integration of bicycle travel with public transportation system, high capacity, and the site of this integration seasons modal integration and its respective areas of influence.

As cited earlier, the article presented here is part of the research *Methodology for Implementation of the cycle network Integrated Public Transportation in Brazilian Metropolises*, particularly, in step on the elaboration of a method that can contribute in the assessment of "best" cycling route integrated with public transportation.

The use of multi-criteria analysis for evaluation of integrated public transport cycling routes will contribute to the improvement of the process of making the decision, because it will allow inclusion of perception of cyclists in the

choice of main criteria influencing the choices of their paths.

3. Methodological Procedure

The evaluation procedure of the proposed cycling routes in this work took as basis a quali-quantitative approach and was developed through the following steps: (1) definition of the study area; (2) structuring the problem (3) assessment of alternatives as presented in Figure 1.

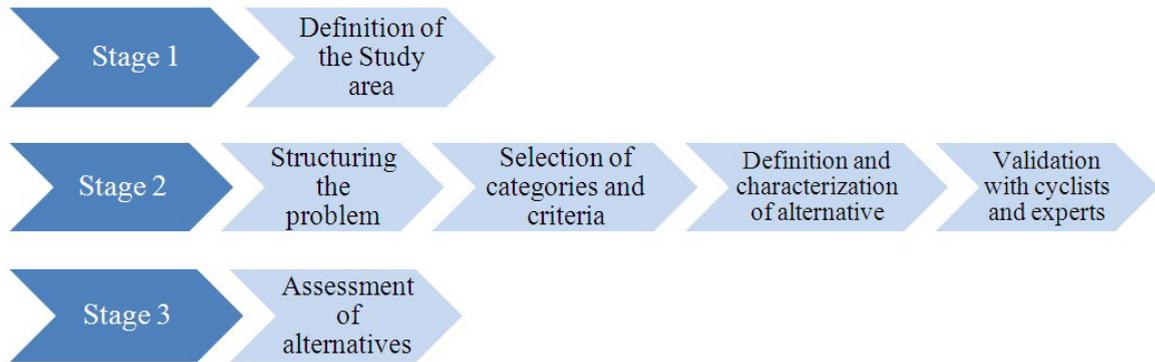


Figura 1: Methodological Procedure

Step 1: Definition of the Study Area: based on literature adopted a radius of 5 km from a station of public transport.

Step 2: Structuring the problem:

2.1- *Selection of categories and assessment criteria:* based on literature adopted a set of criteria grouped by categories which were subsequently validated by the main actors of the decision (cyclists and experts in the area of urban mobility).

2.2-*Definition and characterization of the cycling route alternatives:* maps were elaborated based on Google Earth to represent the cycling routes which were drawn taking into consideration the accessibility attributes; continuity; connectivity; hierarchy road and density of urban facilities. These routes have as origin a neighborhood in the study area and as the destination public transport station.

2.3 *Criteria Validation*

2.3.1 With cyclists – use of the Focal Group technique and content analysis

2.3.2 With experts – use of Weighting Technique (weights and notes).

Step 3: evaluation of the alternatives

After the definition of the criteria and alternatives of routes was conducted to assess the "best" choice of cycling route integrated with public transportation. For this evaluation was used the Method of Multi-criteria Analysis based on AHP-Analytic Hierarchy Process. This method uses a hierarchical structure with the following elements: objective, criteria, sub-criteria and alternatives by performing a comparison to the pair, through the fundamental scale of Saaty (1 to 9). For this assessment used the Expert Choice a software that is based on the AHP.

This article will introduce the steps 1; 2.1; 2.2 e 2.3.1 of the proposed methodology.

3.1 Definition of the study area

As stated by Ribeiro (2005), the bicycle is a mode of transportation, viable for small and medium distances and, when integrated with other modes, allows to achieve various desired destinations. It is an excellent option for holding travel whose distances are long for pedestrians, starting from 1 km, and short enough to reduce the efficiency of public transport 4-5 km.

This limitation of bicycle use is originated from the vehicle tensile mode itself, based on physical effort from the user. However, it is difficult to define this ray in maximum terms, due to the large variation of the factors that influence and are, on one hand, the ability and fitness of each individual and, on the other hand, some characteristics of city, such as topography, climate, road infrastructure and traffic conditions. The limited action scope ceases to be an unfavorable factor when the

bicycle is used as a means of complementary transportation and is integrated to both road and metro stations (Brasil, 2007). As a complement to the integration bike lane routes arise and they propose to meet the displacement of the rider since the departure of his origin to the arrival of any of the modes of transportation (train, metro, bus or boat) that will complement the journey to his final destination .

It was found through literature (European Commission, 2000; Rajan, 2005; Aquino .2007; Paiva, 2013; Oliveira, 2013) that the radius of the area for the integration of public transport with the bicycle may vary in a range of 1.8 to 7.5 km depending on geographic conditions and transport and traffic patterns of each locale. From the analysis of this literature was adopted in this work the damn area of 5 km from the station of transport chosen for study. This demarcation was considered a travel time of up to 20 minutes by bicycle to the path from the origin to the public transport station traveling at a speed of 15 km/h.

Figure 2 presents the coverage area of the Station Mussurunga, Salvador-Bahia which will be the the public transport station to be analyzed in this paper.

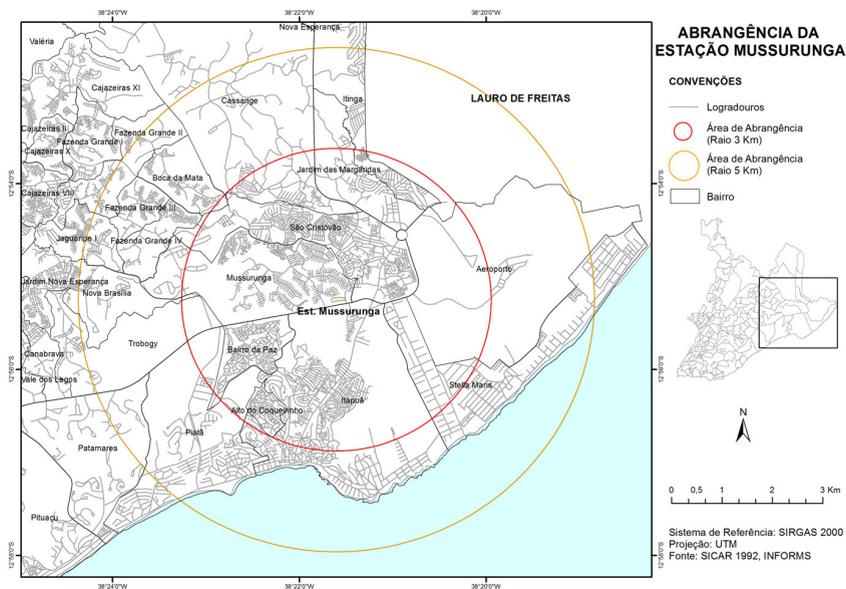


Figure2: Coverage Area Mussurunga Station

Source: prepared by the author using the Cartographic base SICAR-INFORMS (1992)

3.2 Preparation of a map of cycle route network to define the possible alternatives.

From the definition of the study area, the next step consists in constructing the map of cycle route network in this area, which corresponds to the set of usable routes for access to the station. For making this map some criteria should be taken, a priori, in order to obtain a coherent and of a greater representation for understanding how the displacement of the cyclist is developed in the study region, up to the integration station. The criteria that guide the construction of the network are:

Continuity: continuous existence to the fullest extent of the area of study pathways, ensuring a free network of major outages, used by users who want to reach the public transport station;

Connectivity: flexibility in the choice of possible scroll routes through the interaction between the main and secondary streets assuming that these are part of the route of the cyclists wanting to arrive to the station;

Road hierarchy: to verify the speed of the track and its compatibility with the route.

3.3 Use of the Technical Focus Group to know the perception of cyclists on the main criteria for the choice of paths (routes), used on their commutes.

For the selection of attributes and the definition of possible alternative routes was conducted a qualitative research with data collection using the Focal Group Technique

Qualitative research has several data collection techniques, including the use of interviews, participant observation and focus group. Being the focus group of these research techniques that collects data through group interactions, with the analysis of the material behavior expressed by speech seized in the discussion of a particular topic suggested by the researcher. The focus group technique can also be characterized as a resource to understand the process of construction of perceptions, attitudes and social representations of human groups (Gondim, 2003).

In this step must be taken into consideration the criteria for use of the focal group technique which can be summarized in the following steps: a) define the groups to participate in the survey taking into account the criteria of homogeneity and heterogeneity as well as to limit the number of participants is limited between six and ten. It is important that the groups consisting of cyclists and they reside in the study area; (b) must be prepared a screenplay where you put research objectives and the criteria raised in the literature for which the moderator leads a discussion whose goal is to raise the criteria considered important to the group in respect of routes to integrate public transport. c) presentation and delivery of maps, the participants, containing integrated routes public transport station from the neighborhoods within the study area. Participants should be encouraged to interact and take ownership of information to analyze.

For the validation of the criteria with the participation of users bikers was suggested the implementation of the Focal Group and Content Analysis technique to collect data and to meet the objective of incorporating the perception of cyclists

3.4 Using the technique of choice for Multicriteria Evaluation of "best" bike lane routes

This evaluation will be conducted with experts and activist cyclists using the method of multicriteria evaluation based on AHP and Expert Choise through software. To base the urban experts and activists in their assessments cyclists mobility will be presented a video with bike lane routes that were filmed from the perception of cyclists captured through focus groups. Note that this step is not presented in this paper.

4. RESULTS - ANALYSIS OF A CASE STUDY

4.1 Characterization of the Study Area

The Region of Mussurunga was chosen to develop the study for presenting large volumes of flow of cyclists that travel through this area, and it is important for having an integration station of public transportation, Mussurunga Station. In Salvador some research on bicycle path mode (Ribeiro et. Al. 2012) showed that a significant number of bicycle users and potential demand for integration of cycling with public transportation in this region were performed.

The study area was initially defined by a radius of up to 5 km starting from Mussurunga Station and this radius encompasses the neighborhoods of Mussurunga, São Cristóvão, Itapuã, Piatã, Patamares. This definition meets the criteria established in the literature that considers the distance to 5 km as appropriate for the integration of cycling with public transportation. However, it has become necessary to restrict the area to match the resources of time and financial research. Thus Piatã and Patamares neighborhoods were excluded from the study. Figure 3 shows the map of the study area.

Mussurunga is a region largely flat and articulates with the Otavio Mangabeira corridor (seafont) through the cross roads: Dorival Caymmi, Orlando Gomes and Pinto de Aguiar avenues. This region has a total area of 4,513 ha, with a population of 175 562 inhabitants and Gross Population Density of 39 hab. / ha (IBGE, 2002). Being a link between income groups of up to 3 minimum wages and the middle class and upper middle class of the city. It is an area booming with several new developments like school, college, housing, shopping center, etc.

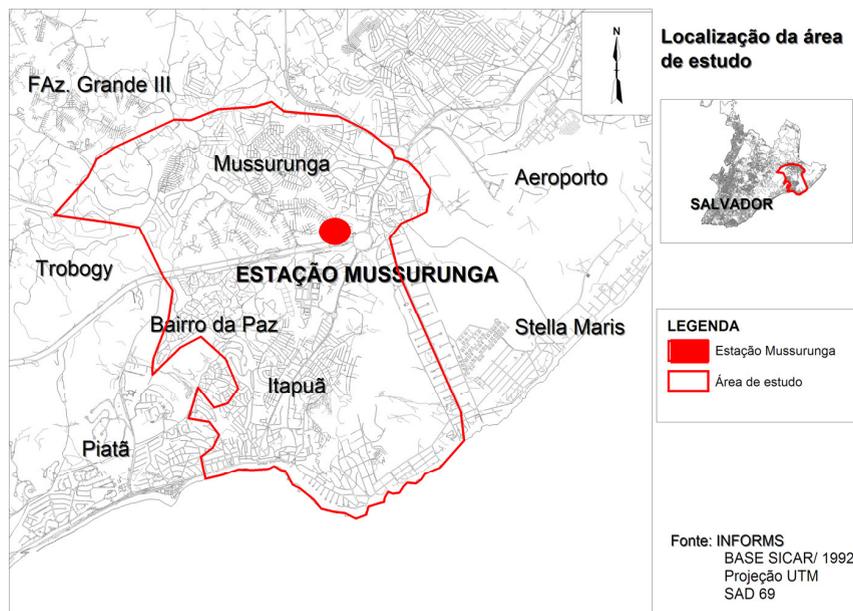


Figure 3 - Location of the Study Area
Source: INFORMS (2014)

The current mussurunga Integration Station has a demand of 40,500 passengers/day (Transalvador, 2014), located in the region of Mussurunga, north of the city, Luiz Viana Filho Avenue (Paralela Avenue) is a road station established in the Integrated Transportation Network - RIT with integration bus - bus, with the prospect of integrating metropolitan bus lines to the future metro line 2 (Lapa - Lauro de Freitas line).

In 2011, UFBA / CNPq project conducted a survey of cyclists in the area around Mussurunga station which aimed to know the use of bicycles as a mode of integrated transportation and presented the following results: the majority of respondents (76.5%) quoted would use the bicycle as a means of transportation, making integration with the station if there was a bike rack, and felt that it should be safe (29.9%), with coverage area (21.0%) and bathrooms / changing rooms (12.8%). (Ribeiro et. al., 2012).

Other important data from this research are related to the profile of the respondents in which the income of the majority is from 1 to 3 MW, among those users of public transportation, the occupation of the majority of respondents is in the trade and services sector, however, construction stands out as a significant occupation, where some neighborhoods stand out: Bairro da Paz (40%); Itapoã (27%) and São Cristóvão (22%), which are part of the catchment area of Mussurunga. (Ribeiro et. al., 2012).

4.2 Map of cycle route network for Mussurunga Station

Considering the criteria of continuity, connectivity and Road Hierarchy described in step 2 Preliminary maps were drawn up on the basis of Google Earth, which were presented to participants of the Focus Groups cyclists in order that they validate the proposed routes. Then, using the SICAR cartographic base and MAPITUDE software (a combination of software and geographic data used for mapping and spatial analysis in networks) a map of bike lanes routes to be evaluated by experts and activists cyclists was prepared using the multicriteria evaluation method based on AHP and Expert Choice through software. The map of cycle routes in the area of influence of Mussurunga station network is shown in Figure 4.

It is worth mentioning the importance of the experience of local cyclists of Mussurunga (focus groups A and B) and knowledge of those on the study area. Thus, as described in step 2 of the methodology a movie of the routes was

drawn from the criteria and the routes chosen by cyclists in the focus groups A and B. This video will be presented to the evaluators (experts on urban mobility and activists cyclists) to contribute in their judgments according to the characteristics of the region.



Figure 4: Map of the network of cycle routes in the area of influence of Mussurunga Station
Source: Prepared by author.

4.3 Analysis of the perception of cyclists on the main criteria for the choice of bike lane routes used on their commutes in influencing Mussurunga Station area.

Cyclists residents surrounding the Mussurunga Station (workers, students) and activist cycle groups were considered the keys actors to compose focus groups. This selection was based on the UFBA-CNPq survey results (2011) mentioned earlier (Ribeiro et. al., 2012) whose presented as main reasons to travel: work, study and leisure. In addition, it was required to the participants the knowledge of the area of study and the use of the bicycle. The representativeness of all the neighborhoods in the study area was guaranteed and that was indicated the participation of 2 or 3 cyclists for each of these neighborhoods

At the proposed work three groups of cyclists were defined (A) Students, (B) Employees of diverse areas of activity, and (C) activists cyclists activists. The composition of the groups was defined by the criteria of homogeneity and heterogeneity being the homogeneity given by Cyclists A,B e C e residing in the study area (A e B). While heterogeneity was given by the representation of users Students, Workers of different places and Activist cyclists.

The recruitment of people to form groups was through contacts with representatives of associations and the Internet through websites committed to the bike. In addition, students were contacted on visits to schools and universities. Regarding the group of workers were recruited through interviews by researchers when driving along the study area. Cycle activists in turn were contacted via email and phone.

After holding meetings with groups we made the transcription of audio and elaborated content analysis in order to categorize the issues and know the criteria used by cyclists at the choice of routes. From this analysis the attributes presented by focus groups of Students (A), Workers (B) and Cycle activists (C) were identified.

After analyzing 18 sub-criteria were submitted which in turn were classified into 5 categories: (1) *traffic*: traffic flow speed, volume of vehicles on the road, heavy goods vehicles on the road side parking; (2) *public safety*: lighting, deserted streets, policing. (3) *infrastructure*: sanitation, degree of continuity of the routes, width of via, bike rack at the station. (4) *environment*: topography, afforestation. (5) *behavior*: conflict between drivers and cyclists,

conflicts between cyclists and pedestrians.

The results of research on user perception of the bicycle on the attributes of their choice of integration paths in the public transport system by applying the technique of focus groups with cyclists students, cyclists workers and cycle activists, groups A, B and C respectively, largely confirmed what was presented in the literature review. The criteria considered as the most important in the individual choice of routes used by cyclists in their paths factors were: (1) the lack of public safety, for the three groups presented reports of theft, especially on the bike theft and fear expressed in riding in the evening. (2) the lack of traffic safety: the way of motor vehicles with high speed generates insecurity both by noise and the wind that scare the rider as the risk of accidents (3) the low quality and type of pavement of roads that cause discomfort and generates health problems, (4) the irregular use of parking vehicles on the street that hinders the passage of the bike but also causes accidents by the unexpected opening of the door of the vehicle.

With regard to the behavior of other drivers, cyclists respondents felt that both drivers of small cars and heavy vehicles (buses, trucks) do not respect cyclists on the road. Another type of conflict faced by the cyclist is with pedestrians walking on the cycle tracks causing accidents and fights with cyclists.

The focus groups also assessed the route alternatives presented in elaborate maps on Google Earth base and validated three routes for each neighborhood, considering the current road conditions. For routes prepared by them to assist in making the map of the network of bike lane routes, the groups highlighted as a priority the need for safety, pavement quality and respect and also the creation of bike lanes "to facilitate and prevent cyclists from using so irregular lanes in danger of being run over" The continuity of the routes was also regarded as an important criterion for the groups. In the studied neighborhoods there are many dead ends, many streets which taper and there is no continuity which hinders the development of a network.

Reducing the speed of the tracks was a condition placed by cycle activists to provide conditions for shared movement of cyclists with cars. But they claim that in Salvador, they do not see the public authorities with that interest. Also in relation to the comments of cycle activists, they demonstrated that they believe the bike expands citizens' right to the city:

"Access to the city, having the right to the city, because no one wants to use all modes, the bicycle is one that frees you from the financial issue of the right to the city because to have the right to the city in relation to transportation, something you need to pay [...] people are increasingly using the bike because it brings social inclusion, in order to give right to the city, you can access the city, you can be in places."

A curious fact which was not found in the literature was cited by both groups A and B (cyclists residents of the study area - workers and students respectively) refers to the use of the bicycle in the "opposite" (which is prohibited by Brazilian Traffic Code) because they are convinced that they are safer that way, they can see the vehicle.

5. Conclusions

The aim of this article was to develop a method that can contribute to the assessment of "best" cycling route public transportation integrated, which consider among other criteria, the factors of individual choice of cyclists.

The structuring of the three methodological steps, as well as the criteria used in each development proved to be satisfactory, with important results in the study.

Both the use of the Focal Group technique and Content Analysis to know the perception of cyclists interviewed about the main criteria for choice of routes, used in its offsets as the division of 3 distinct groups of cyclists (students, workers and activists cyclists) were satisfactory as allowed for the debate and the exchange of knowledge between these groups.

The research on the perception of the user of the bike over the choice of attributes your paths in integration to the public transportation system has demonstrated that the main criteria influencing your choices are related to security aspects (public and transit).

It is believed that the study conducted in the area of influence of Mussurunga station represents an embryo of this type of study, which can be replicated in other cities and other countries, in order to obtain the perceptions of cyclists on the main criteria for choice of cycling routes to other realities, to be searched and compared, as well as likely to strengthen this line of research within the Universities.

Whereas the results of this study cannot be generalized, because based on an exploratory research on perceptions of cyclists respondents. However, this case study could serve as the start of a discussion for researchers wishing to address the integration theme of the bicycle with the passenger public transportation.

That's why it is suggested the continuity of this research in order to develop comparative studies of cases with other locations in Brazil and abroad where there are condition and interest to perform this type of integration

Finally, it is expected that this methodology can be used as a tool to aid decision in city planning and sustainable mobility.

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