

A COMPARATIVE STUDY ON CYCLISTS PROFILE, CYCLING TRIPS AND CYCLISTS BEHAVIOR IN TWO AREAS OF RIO DE JANEIRO

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RESUMO

A crescente urbanização percebida em países em desenvolvimento tem como consequência o aumento no volume de deslocamentos e, em muitos casos, também o aumento do uso de meios de transporte (individual) motorizados. Por sua vez, o elevado nível de motorização gera congestionamentos, piora a qualidade do ar, aumenta o tempo médio de viagem entre outras consequências. A bicicleta, um meio de transporte não poluente e econômico, surge como uma possível alternativa para diminuir tais efeitos. Entretanto os ciclistas e o uso da bicicleta apresentam características distintas dos modos de transporte já consolidados. Com o intuito de compreender este segmento, faz-se necessário identificar quem são os ciclistas, de que maneira a bicicleta é usada em deslocamentos e quais suas preferências e necessidades. O objetivo deste trabalho é identificar as diferenças entre dois bairros do Rio de Janeiro relativas ao perfil dos ciclistas, às características das viagens de bicicleta e às preferências e necessidades relacionadas a este modo.

ABSTRACT

The increasing level of urbanization in developing countries leads to a higher number of trips and, in many cases, also an increase in individual motorized modes' use. In turn, the higher level of motorization has as consequence congestion, decrease in air quality, longer travel time amongst others. The bicycle, a green and low cost alternatives, emerge as a viable option to minimize these effects. However bicycle use and users have particular characteristics/needs as compared to the consolidated modes. In order to understand this segment, it is crucial identify who are the current users, how do they use the bicycle and what are their preferences and needs. This paper aims to identify the differences between two neighborhoods in the city of Rio de Janeiro with respect to cyclists profile, bicycle use and behavioral aspects related to this mode.

1. INTRODUCTION

The world is facing an urbanization process, especially in developing countries, since in developed countries this process is already consolidated, and the negative impacts as consequence are unavoidable. In big cities these impacts are even greater, given that the spread of the low and middle income housings into suburban areas is increasing and public transport is not able to provide a good accessibility to the inhabitants, depending on the downtown jobs. One of the greatest villains in this picture is the intense use of motorized modes of transport, especially the car. Increasing congestion, low air quality, decreasing quality of life and time loss are, among others, some of its consequences.

In this sense, the use of bicycle as a means of transport can be a good alternative to cope with these problems. The introduction/improvement of the bicycle within the city's transport system presents advantages not only to the individual but also to the city as a whole. In some developed countries, mainly in Europe, this mode is already consolidated and the bicycle is part of the transport system and of the city, such as in The Netherlands and Denmark.

However, in order to improve the quality of bicycle infrastructure and also other factors affecting negatively the use of bicycle as a mean of transport, it is crucial to understand who are the cyclists, how do they use their bicycles, what are their needs and preferences. Being aware of these aspects it is possible to tackle target areas and target groups where improvements can be implemented and the use of this mode can be enhanced.

The aim of this paper is to provide an overview of the cyclists' profile, bicycle use and behavioral aspects related to this mode in two different neighborhoods in the city of Rio de Janeiro, one located at the central core of metropolis and another at suburban area. The hypothesis is that the use of bicycle in these two areas might be different as it assumed that bicycle use is influenced by socioeconomic characteristics and local characteristics.

2. BACKGROUND

The bicycle is a good transport mode alternative for a variety of aspects and its benefits can be experienced both by the individuals who use this mode and by the city in a broader sense.

The insertion of the bicycle in transport system can improve the city's quality of life, affect positively the environmental conditions and also optimize public investments in the long term. The change from motorized modes to the bicycle would result in a better traffic flow as the number of motorized vehicles would drop. The need of public space assigned to parking lots would decrease and those areas could be used to accommodate other public facilities. The more intense the use of bicycle is the larger will be the positive impacts in the city and peoples' quality of life.

Regarding individuals accessibility, it is possible to distinguish two levels of accessibility: micro-accessibility and macro-accessibility, according to the concept of environmental zones developed by Buchanan in *Traffic in Towns* (*apud* Martins et al, 2004), which can be defined as a territorial unit which connection access or a point with the structural transport network protects it from motorized trips and, mostly, of any through traffic

Martins et al (2004) suggest that, in order to provide sustainable transport alternatives, micro- and macro-accessibility should be integrated, as "the densification limits of an environmental zone are entailed to the limits of environmental capacity and of transportation inside and outside this zone, i.e., giving conditions of internal circulation (micro-accessibility) and of external circulation (macro-accessibility)". According to the same authors, micro-accessibility should be achieved, as much as possible, by the use of non-motorized modes (such as walking and cycling).

Cycling permits, especially for low income groups, individuals to circulate and reach their destinations within environmental zones with a non-polluting and affordable mode, which would enable them to take part of as many activities they want, since transport would no longer represent a cost.

Developing cycling locally has also positive effects in terms of macro-accessibility. Bicycle has a higher speed than walk, what makes possible to cover the same distance in shorter time, and as a faster mode bicycle can enable individuals to reach a further but direct mode to their destinations. In places with no fare integration (like most of the cities in Brazil), this leads to savings in PT fares. In this context, cycling would contribute not only to micro-accessibility but also with macro-accessibility.

The bicycle is not only an environmental friendly mode of transport, but it is also a healthy way of traveling, it demand less public space than other alternatives and even more important for developing countries it is almost a free mode. Once the individual owns a bicycle, there are barely any costs involved on its maintenance. Furthermore, when compared to walk, another non-motorized mode, it is faster, three times faster, according to Advani and Tiwari (2006).

The benefits of the use of the bicycle can be experienced not only by the users, but also by all citizens and the city itself. The more intensive use of bicycle can improve traffic conditions and increase the traffic flows. It can induce more PT trips if a good integration is provided, since the bicycle can be used to access the PT system.

Since this mode of transport can be accommodated using less space than other motorized alternatives, public spaces can be used for parks, square and sport courts and other social purposes encouraging the use of public space to socialize and seize the city. In addition the current road system could be less overloaded and the circulation improved.

Acknowledging the importance of the bicycle in an equitable and efficient transport system, both the state of Rio de Janeiro and the municipality of Rio have launched programs to encourage and develop this mode of transport.

The objective of the state program “Rio – Estado da Bicicleta” (Rio – State of the bicycle) is to encourage the use of bicycle especially for those who currently walk and also to access PT by supporting the municipalities to improve bicycle infrastructure.

In the city level, the municipality developed the program “Rio, Capital da Bicicleta” (Rio, Capital of the bicycle) which aims to improve PT and urban mobility and also to diminish GHG emissions by continuously inserting the bicycle in the transport system and promoting education campaigns.

3. STUDY DESIGN

3.1. Study areas definition/description

For the present study two neighborhoods in the city of Rio de Janeiro were selected: Copacabana and Santa Cruz (Figure 1). The two areas present very distinct characteristics.

Characteristics	Copacabana	Santa Cruz
Population*	147021	191836
Area*	410ha	12504ha
Density	359inh/ha	15inh/ha
Income***	R\$1623	R\$206
HDI***	0.96	0.74
Urbanized area**	63%	16%
Number of formal bus lines****	98	53

* Source: IBGE, 2000 (a).

** Source: Secretary of Environment (SMAC), 2001.

*** IBGE, 2000 (b) ; Income refers to monthly per capita income and in the 31st of December, 2000 US\$ 1 = R\$ 1.949

**** Inventory based on Secretary of Transport data

Table 1: Comparison of characteristics across neighborhoods

The population of Santa Cruz, a suburban neighborhood located in the West Zone, is composed mainly by low income individuals, the HDI (human development index) and the density are amongst the lowest within Rio de Janeiro, and the public transport provision is scarce, unable to cover its vast territory. Santa Cruz presents the highest use of bicycle as transport mode in the city, both in generating and attracting trips. There are cycle paths in Santa Cruz, but the extension is not significant, they are restricted to the central area of the neighborhood and they are not part of a network, but only single stretches not interconnected.

Copacabana is located in the South Zone of Rio de Janeiro, and it is inhabited by low, middle class and high income individuals. Its density is one of the highest in the city, it counts on abundant transport provision, with a dense bus network as well as three metro stations. The bicycle is not much used as transport mode and there are cycle paths alongside the coastal line. On the other hand, there is an intense use of the bicycle for recreational purposes and physical activities, and the cycle paths are intensively used for these purposes. Recently the municipality introduced a “30km zone” in Copacabana, limiting the speed of motorized vehicles in some streets.

3.2. Methodology

A total of 206 questionnaires were responded by bicycle users in the two neighborhoods mentioned above. The bicycle users were randomly approached when they were parking or taking their bicycle and also during the cycling. The aim of this study was to identify the profile, the preferences and the characteristics of the trips made by any type of bicycle user in the two selected neighborhoods, and not a specific category, such as commuter or leisure user. The respondents were approached in week days during the whole day to ensure that all types of users were contacted, not only commuters (morning and afternoon peak) but also utilitarian and leisure users. The purpose of this survey was to allow the comparison between users of two distinct neighborhoods and does not represent the universe of bicycle users in the city of Rio de Janeiro as a whole. The subsequent section gives an overview of the bicycle users' profile.

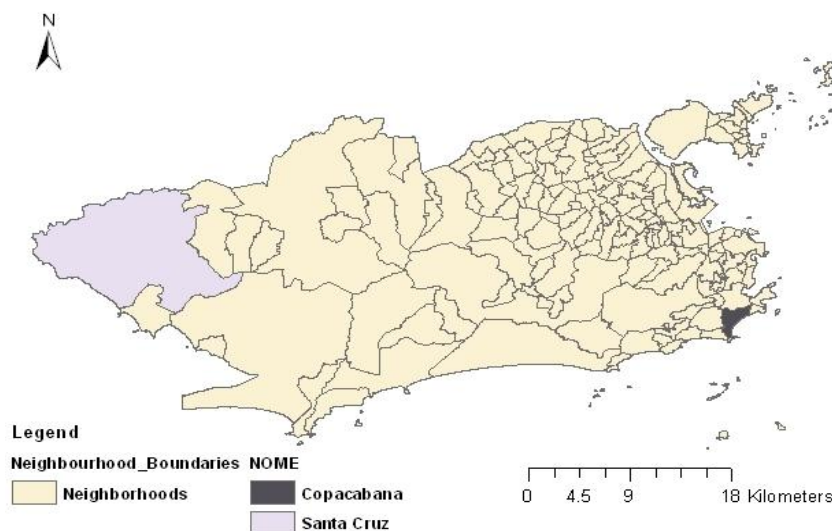


Figure 1: Study areas location

4. RESULTS ANALYSIS

4.1. Cyclists profile

Regarding socioeconomic characteristics, the cyclists were asked about gender, age, income, bicycle ownership, car ownership and car access (if the person does not have a car, but have access to one, as for example the partners' car or parents' car).

Most of the bicycle users (more than 80%) are male, confirming the findings of other studies, (Pezzuto, 2002; Ribeiro, 2005; Maia and Moreira, 2010) and there is no significant difference about the percentage in Santa Cruz and Copacabana.

In Copacabana the cyclists are younger than in Santa Cruz, with 60% being under 35 years, whereas in Santa Cruz the share for the same age range is 40%. In Santa Cruz the age range is more equally distributed amongst the categories, and the higher proportion is of individuals with 45 to 54 years.

The income range also differs across location. In Santa Cruz, most of the cyclists earn up to 2 minimum wages (MW) and the percentage of individuals who have a salary higher than 3MW is less than 15%, whereas in Copacabana this portion is higher than 30% (the value for the minimum wage in Rio de Janeiro for the year of 2011 is R\$608). It is also interesting to notice that the dependents (individuals who do not earn their own salary and therefore depend on other's income, such as parents or relatives) in Copacabana are more numerous than in Santa Cruz and the unemployed are frequent in Santa Cruz.

When it comes to bicycle and car ownership, there is also a distinction according to the neighborhood. In Santa Cruz more than 80% of the respondents own a bicycle whilst in Copacabana this percentage is less than 70%. This can be explained by the more frequent use of this mode in Santa Cruz than in Copacabana, as mentioned above. On the other hand, the car ownership and car access are higher in Copacabana than in Santa Cruz, again explained by the income difference in both areas. However, it is necessary to highlight that the difference amongst car owners' percentage is not that significant across neighborhoods. This indicates that even in Copacabana, the bicycle is more used by those who do not have a car (Figure 2).

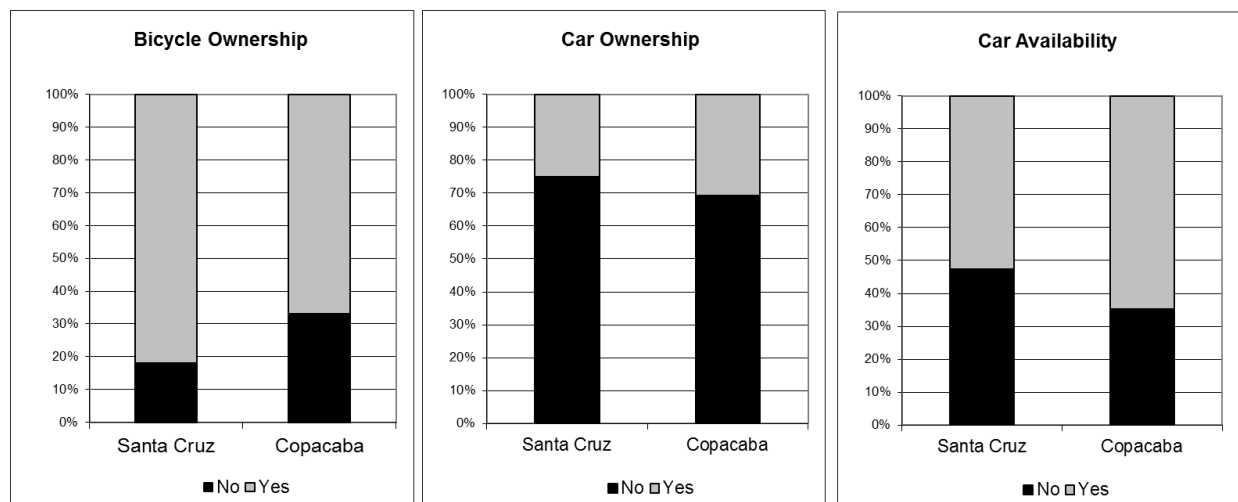


Figure 2: Vehicles ownership by location

4.2. Characteristics of bicycle trips and general bicycle use

The trip characteristics are analyzed based on questions about trip purpose, trip frequency, parking type and frequency neighborhood of origin and destination, integration with other modes and travel time.

The graphs below (Figure 3) show the distribution of origin and destination activities for both locations. In Copacabana the origin activities (the activity the person was taking part in before the bicycle trip) are better distributed than in Santa Cruz. The main origin activity in Copacabana is compulsory one (work and study), whereas in Santa Cruz maintenance activities (shopping and personal affairs) are the principal one.

The main destination for residents of Santa Cruz is home, followed by maintenance and compulsory activities. In Copacabana the main destination is home, firstly, and subsequently work and study. Other activities play a minor role.

Analyzing these results, it is possible to detect that in Copacabana almost 80% of the cyclists use the bicycle for compulsory activities (work and study), and this number is much lower for Santa Cruz (around 45%), considering both origin and destination activities.

The chain of activities by bicycle was also analyzed. By asking the origin and destination activities, it is possible to detect whether the trip made by bicycle is a simple return trip (home-activity-home) or if it is followed or preceded by any other purpose (home-activity-activity-home), indicating a trip chaining.

The results suggest that this practice is more common in Copacabana, as approximately 55% of the trips have origin or destination at home, meaning that 45% of trips are associated to other purposes. The percentage of trip chaining by bicycle in Santa Cruz is smaller, close to 15% of the total trips. This difference could be explained by richness of the activity opportunities in Copacabana, given by the land use mixture within this dense area.

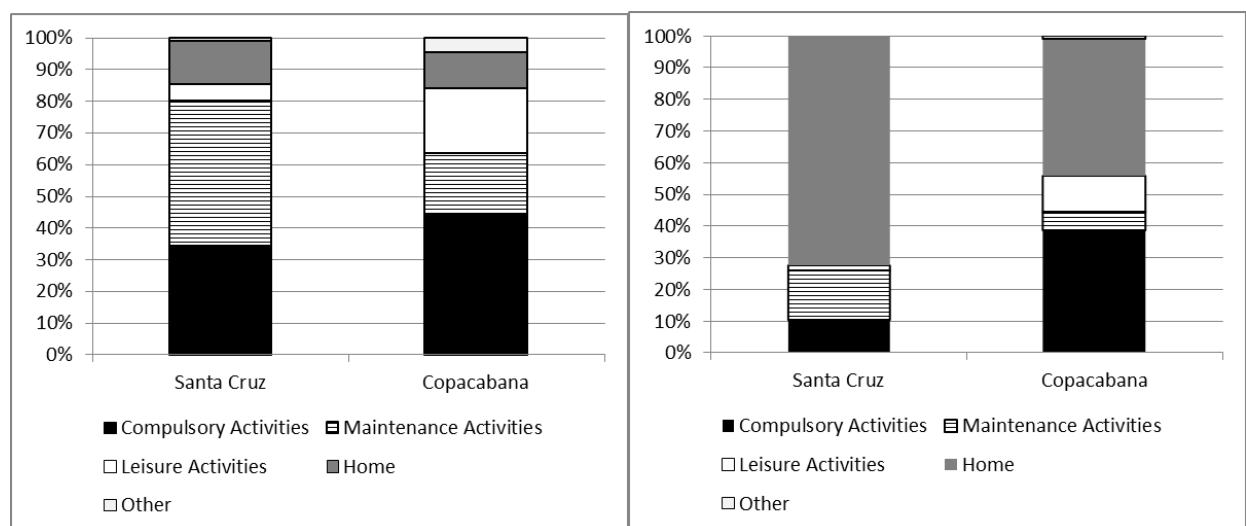


Figure 3: (a) Origin activities and (b) destination activities

The bicycle trips are integrated to other modes of transport in approximately 20% of the cases, in both neighborhoods. In Santa Cruz the integration is mainly with bus and train, whereas in Copacabana is mainly with bus and metro.

Where the people park their bicycle also varies across neighborhoods (Figure 4). In Santa Cruz, three quarters of bicycle users park the bicycle legally (public and private parking have the same share), and one quarter of them park the bicycle illegally, at the street, chained to poles, trees or fences. In Copacabana the picture is quite different, with more than half of the cyclists parking their bicycles illegally. Approximately 30% park them in private locations and only 10% in public parking.

The higher use of public bicycle parking in Santa Cruz is probably due to the more plentiful supply of public parking spaces, though still not sufficient, in this region than in Copacabana. Also in Santa Cruz there are at least two private parking places, with capacity of approximately 500 bicycles each, which justifies the high use of this type of parking in this location. In Copacabana, the use of private locations refers to private buildings and not to a private parking location *per se*.

When it comes to the type of the trip, whether intra- or inter-neighborhood, the patterns are also different depending on the area. Most of the trips in Santa Cruz are intra-neighborhood (close to 80%), meaning that the origin and the destination of the trip is within the borders of the neighborhood. The majority of trips in Copacabana also take place within the limits of the neighborhood; however, the percentage is lower (around 52%).

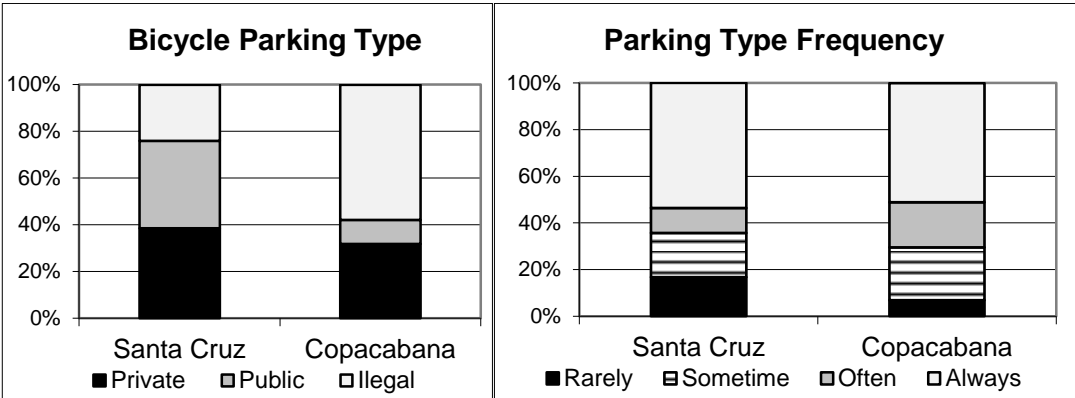


Figure 4: Parking characteristics

It is understandable that most of the trips in both areas are intra-neighborhood, as bicycle is a human-powered mode and the distances covered by this mode tend to be not too long. The difference in percentage in both cases can be explained by the size of the neighborhood: the area of Santa Cruz is 30 times larger than the area of Copacabana. This means that an inter-neighborhood trip in Copacabana could still be an intra-neighborhood trip in Santa Cruz, as trip type is a relative measure.

On the other hand, travel time is an absolute measure. Figure 5 illustrates the distribution of travel time by bicycle in both study areas. More than half of the trips in Santa Cruz take up to 15 minutes and the portion of longer trips (more than 45 minutes) is smaller than in Copacabana. It was expected the travel time in Santa Cruz to be higher than in Copacabana, due to its larger area, however the results suggest otherwise.

One possible explanation for this could be the fact that in Copacabana the traffic is much more intense and complex. In every block there is a traffic light and therefore the average speed can be lower than in Santa Cruz. In the latter, the traffic flow is much lighter and most

of the local crossings do not have traffic lights, which enables a higher average speed to the bicycle. However, this aspect needs the further investigation.

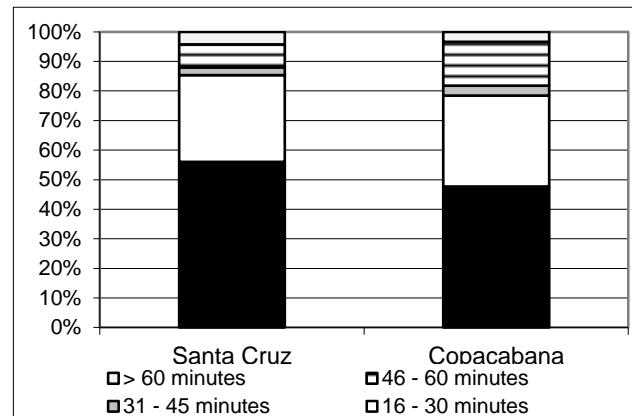


Figure 5: Travel time by Neighborhood

4.3. Cyclists preferences

In this section the preferences of the cyclists regarding type of parking location, route choice, bicycle use, barriers and opportunities for cycling are identified and a comparison across neighborhoods is presented.

The main reason for choosing the parking location is the proximity to the destination, regardless of the neighborhood, however, the percentage is much higher in Copacabana than in Santa Cruz (Figure 6).

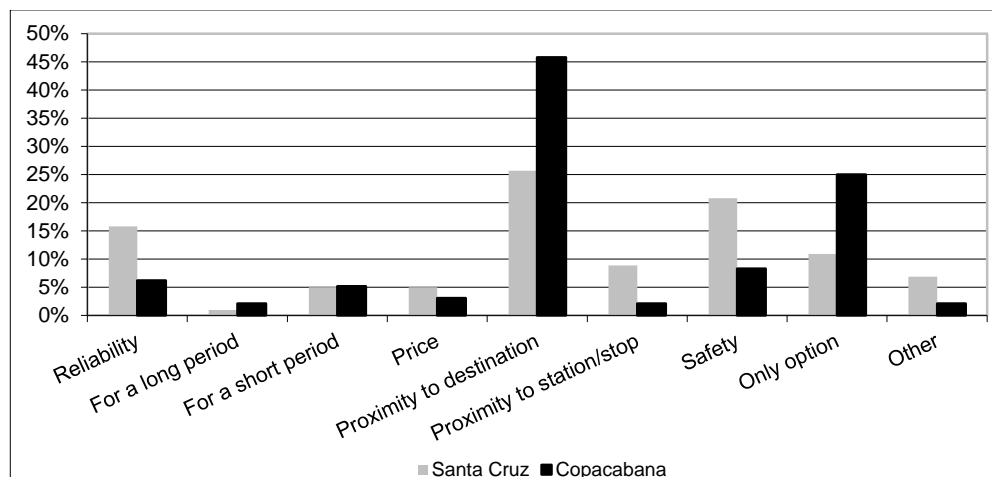


Figure 6: Reasons for parking location by neighborhood

The second reason in Copacabana is “only option” whereas in Santa Cruz is safety. In this neighborhood the attributes “reliability” and “only option” are also significant in parking choice.

When the reasons for choosing a parking location is investigated in association to the type of parking, the attribute “reliability” is mentioned mainly by private parking users, whereas the attribute “only option” is mainly connected to illegal parking. Surprisingly, safety is related to public parking. It was expected that this attribute would be mentioned by individuals who use private parking spaces, as the feeling of safety when parking the bicycle in a restricted access

area is higher than in public spaces where anyone can have access to the bicycle. The proximity to destination refers mainly with private and illegal, but private is also mentioned, as private parking are available in more locations than private ones, and the same holds for illegal, since it can be done anywhere.

When it comes to the reasons for choosing the bicycle as the mode of transport, the speed is the main reason in both areas. In Copacabana, “health” and “flexibility” are, in this order, also relevant reasons for using the bicycle. These two attributes are, respectively, the third and the fourth in Santa Cruz, since “price” is the second one and plays an important role for the people living in this neighborhood (Figure 7).

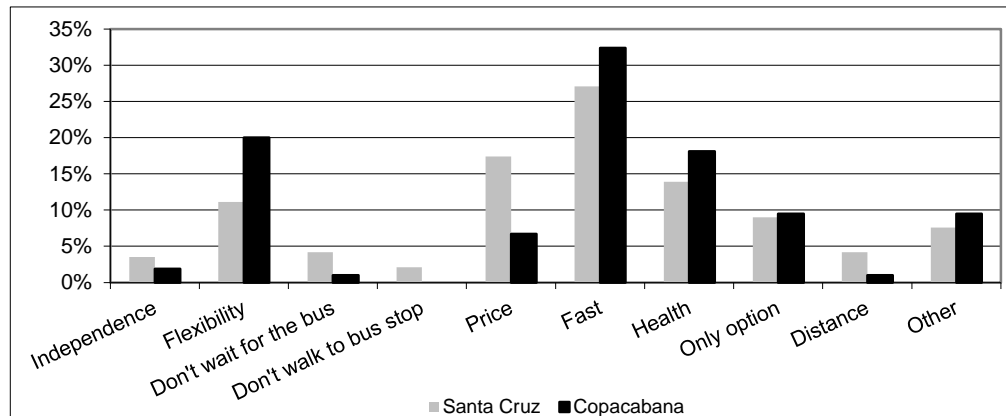


Figure 7: Reasons for using bicycle by neighborhood

The most important reason for choosing the cycling route is the speed regardless the area (Figure 8). The shorter way (the closer alternative) is the second most relevant factor in route choice, even though the percentage is much higher in Santa Cruz. In Copacabana the safer route, in terms of traffic flow, is also frequently mentioned. It is interesting to highlight that in Copacabana some interviewees choose their route where cycleways are available and this attribute was not mentioned at all in Santa Cruz, even though they exist.

The main problem indicated by the respondents in using the bicycle is the lack of respect from the drivers. Since there are not a considerable network of cycle paths available in both locations investigated, the cyclists are obliged to share the roads with motorized vehicles, and the results show that the drivers do not respect the cyclists (Figure 9).

The residents of Copacabana are more sensitive to the weather conditions than the ones from Santa Cruz. Looking at the related trip purpose in each neighborhood, it is clear that in Santa Cruz those who point the weather as a barrier are those who use the bicycle for occasional trips, such as shopping or personal affairs, whereas in Copacabana, most of respondents use the bicycle for commuting. One possible explanation for this fact can be that the commuters from Copacabana have other alternatives to go to work when the weather is not favorable. On the other hand, commuters from Santa Cruz cope with the possible unfavorable weather because there is no other option to get to their jobs. Still in Santa Cruz, one possible reason for the lower proportion of “weather” as a barrier to cycle can be the fact that the occasional trips are more flexible and can be made any time of the day, while work trips are, in general, more strict and have to be made in a specific time, usually in the morning peak.

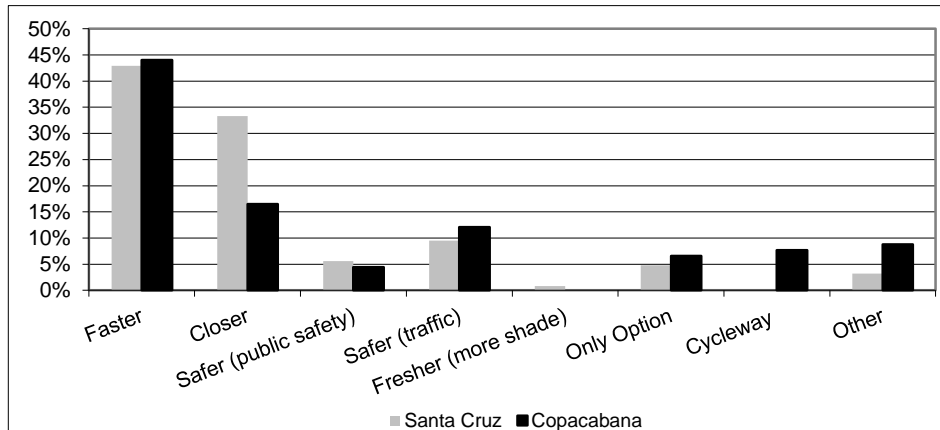


Figure 8: Reasons for route choice by neighborhood

In the same neighborhood, the lack of cycleways is cited as a barrier for cycling and the traffic is also more frequently mentioned in this neighborhood than in Copacabana. These indicate that the perceived cycling condition is better in the former than in the latter location.

The level of satisfaction with the current bicycle conditions is higher in Copacabana than in Santa Cruz, expressed by the attributes “nothing” (the original question in the questionnaire was “what are the main problems in using the bicycle?”). It is interesting to notice that even with a higher satisfaction level the use of bicycle in Copacabana is still smaller as compared to Santa Cruz.

When it comes to the improvements necessary to enhance the overall cycling quality, the provision of cycleways is the dominant answer in both locations. For all residents it is necessary to improve public safety, though in Copacabana the parcel is higher. In Santa Cruz the bicycle users also demand better lightning and better parking conditions (Figure 10).

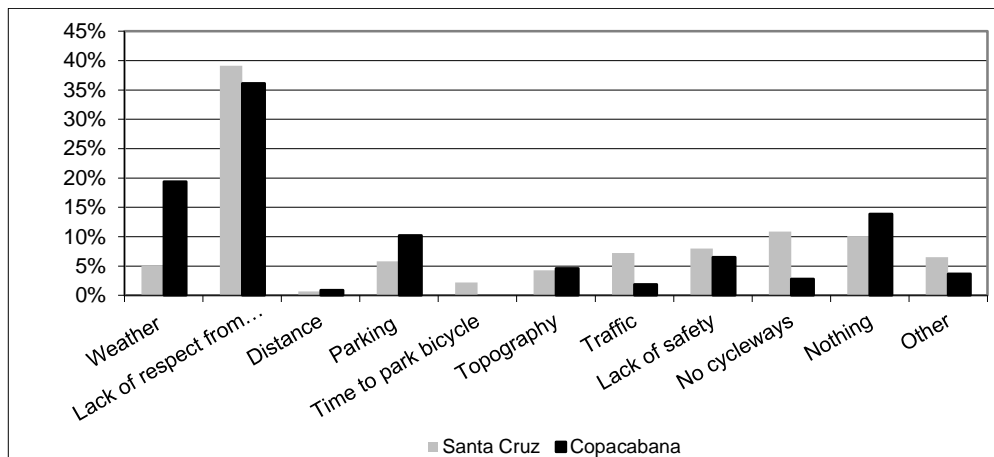


Figure 9: Barriers for cycling by neighborhood

In a previous section it was shown that more than half of the respondents of Copacabana park the bicycle illegally. However the parking condition is not frequently mentioned as a necessary improvement in the neighborhood.

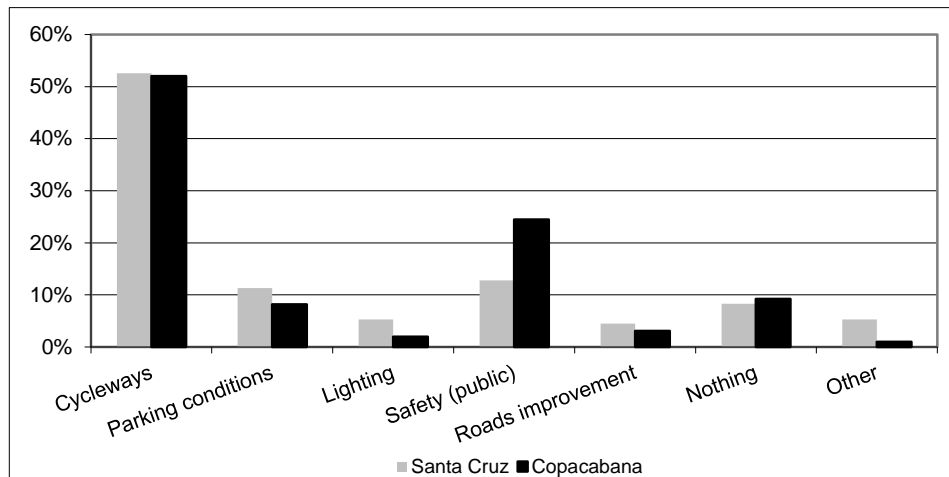


Figure 10: Opportunities for cycling by neighborhood

5. CONCLUSION AND RECOMMENDATIONS

The aim of this paper is to provide an overview of cyclists' profile, preferences and bicycle usage in two distinct areas of Rio de Janeiro. Looking at different areas allows comparison, and it is possible to identify what can be a general characteristic or behavior or a location-specific characteristic or behavior. Results show that there are differences across the different locations, and this should be taken into account by urban planners and policy makers.

The use of bicycle mainly by men is common to both locations, and also confirms the findings from other studies. Regarding age, in Copacabana cycling is more frequent amongst youngsters, whereas in Santa Cruz there is a better distribution among all age ranges. The bicycle is more frequently used as a means of transport by those who have no access to a car, in both areas, however the bicycle ownership in Santa Cruz is higher than in Copacabana.

Regarding the use of the bicycle, in Copacabana people tend to use this mode for compulsory trips (work or study) whereas in Santa Cruz people cycle for different purposes, such as work/study, shopping, personal affairs and social activities.

Bicycle trips in Santa Cruz are mainly intra-neighborhood. For transport planners this is relevant information, especially for the implementation of bicycle related infrastructure and policies (cycleways, speed control for cars), knowing that the focus should be inside the boundaries of the neighborhood. Obviously, it is crucial to know origins and destinations in order to allocate the infrastructure where there is need for it.

On the other hand, in Copacabana there is a significant portion of inter-neighborhood bicycle trips, meaning that the cycleways should be part of a network, encompassing the bordering neighborhoods, as well as other improvements.

Bicycle users tend to park their bicycle close to the destination, as the results show. The high portion of illegal parking, particularly in Copacabana indicates that individuals are not willing to look for a formal public parking location; instead they will lock their bicycle in a pole or a tree, close to the destination.

It is then necessary to provide more formal parking options so that cyclists can park their bicycle legally. Knowing where the main destination activities are is helpful for urban

planners to establish the areas/locations where proper parking spaces should be allocated. It should be encouraged by municipality, that the local commerce, services and another establishments provide and maintain bicycle parking facilities for free.

The results confirm the benefits related to the bicycle as a means of transport extensively reported in the literature: the bicycle is a fast, flexible and healthy manner to travel.

For transport planners it is important to consider bicycle users opinion on the route choice. This is relevant not only for designing cycleways but also when implementing pro-bicycle policies, such as motorized vehicle speed restriction and traffic signals synchronization. Cyclists tend to choose the faster way to get to their destination, which means that slopes and traffic lights tend to be avoided. In addition the traffic is also taken into account when a route is chosen, and people prefer safer ways, suggesting that roads with less traffic flow and lower speeds are preferred.

The findings suggest that the level of bicycle use is not related to the perceived conditions of this mode as in Santa Cruz the bicycle is much more frequently used than in Copacabana even though the perception of the current conditions for cycling are better in Copacabana.

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