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## **Influence of attitudes with respect to cycling on the perception of existing barriers for using this mode of transport for commuting**

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### **Abstract**

The aim of the present research was to examine whether an individual's attitude towards cycling influences his perception of barriers (perceived behavioral control) for cycle commuting. Attitudes and perceived behavioral control were measured using psychological constructs, following the Theory of Planned Behavior. Data collection for this research was conducted in a public college in a Brazilian medium-sized city. The results indicate that the respondents have a positive attitude to cycling for four aspects: environmental benefits, health benefits, economy and feeling of independence. For other eight aspects (better observing the landscape, parking, speed, prestige, effort, risk of accidents, risk of being assaulted and exposure to sun and rain) the general attitude is negative. Perceived behavioral control (barriers) was assessed in relation to six possible obstacles to cycling: lack of infrastructure, lack of safety, distance, skill, slopes and climate. The main deterrent against cycling was lack of adequate cycling infrastructure. Lack of safety (which is associated with the absence of infrastructure) and slopes are other strong obstacles for commuting by bicycle in the city. Individuals who have a negative or neutral attitude toward cycle commuting are not very different in their perception of barriers for cycling. The individuals who have a positive attitude perceive weaker barriers (they have stronger behavioral control). In contrast, a very negative attitude is associated with the perception of stronger barriers.

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## 1. Introduction

In recent years, the bicycle has assumed an increasingly important role in transport policies due to its environmental and health benefits. Local governments in many Brazilian cities are currently investing in cycle network projects, encouraged by resources available from the Ministry of Cities (Brazil, 2007).

However, only this government effort may not be enough to ensure a greater participation of bikes in the modal split of Brazilian cities. It is also necessary to know the factors that stimulate individuals to use (or not to use) the bike for their daily trips. Thus, transportation policies and strategies could be targeted at the factors that specifically motivate the use of bicycles.

What makes someone choose to pedal? For travel patterns to be modified if it is necessary to understand in detail the behavior of individuals and the reasons why they choose a particular mode of transport. If the groups of people would like to cycle are identified, individuals with similar characteristics could be more effectively encouraged by means of specific policies and strategies.

The success of campaigns and policies to reduce car use depends largely on understanding the factors that influence an individual in their modal choice. In general, however, interventions to encourage the use of alternative modes (public and non-motorized transport) have been based on informal conceptualizations, designed without prior research and focused mostly in providing information about the negative consequences of using the automobile.

This information is not generally sufficient to change behavior. It has already been determined that the fact that an individual decides to take a trip by automobile or otherwise has little to do, for example, with his knowledge about the environmental impacts of the extensive use of the automobile (Anable, 2005; Abrahamse et al, 2009). Indeed, it has been found that there is a complex interaction between many factors when an individual makes a choice: beliefs, values, emotions, attitudes and other personal characteristics (Bamberg et al, 2003; Chen and Chau, 2011).

Among the various models that have been proposed to analyze this complex interaction between the behavior of individuals and their personal characteristics, many are based on the Theory of Planned Behavior (Ajzen, 1991). Willis et al (2013) present a comprehensive review of the use of this theory in studies related to cycling.

In this context, the aim of this paper is to describe the use the Theory of Planned Behavior to examine the attitude and perception of barriers of a group of individuals (faculty, students and staff of a public college in a Brazilian medium-sized city) with regard to the use of bicycles as a mode of transport for commuting.

## 2. Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is based on the premise that individuals make rational use of available information when making behavioral decisions (Ajzen, 1991).

A central hypothesis of TCP is that the intention is the sole determinant of psychological behavior. The intention is seen as a summary of all the pros and cons that one takes into consideration when deciding whether to adopt certain behavior and is determined by three independent psychological concepts: Attitude, Subjective Norm, and Perceived Behavioral Control.

### 2.1. Attitude

The attitude of an individual is based on his behavioral beliefs (what the individual believes will happen if he performs certain behavior) and consequences (positive or negative) of adopting this behavior. Having a positive attitude towards the bike increases the likelihood of using this mode of transport for commuting.

With reference to attitudes that positively influence the option for the bicycle as a mode of transport, some authors highlight the concern about the environment, the pleasure of riding a bike and the not liking to drive (Dill and Voros, 2007; Handy et al, 2010; Heinen et al, 2011; Xing et al 2010, Handy and Heinen, 2012).

On the other hand, some negative attitudes are: the belief that driving is a symbol of independence and freedom, enjoy driving and the perception that the individual needs the automobile to perform his activities (Jensen, 1999; Xing et al 2010, Handy et al, 2010).

Dill and Voros (2007) showed that having a positive attitude towards cycling increases the likelihood of using this mode of transportation for utilitarian trips. Heinen et al (2011) in a survey conducted in the Netherlands concluded that the attitude toward the benefits of cycling (e.g., convenience, low cost, health benefits) is an important factor in the option for the use of bikes. These researchers also found that individuals who make longer trips have, in general, a more positive attitude to cycling than individuals who make shorter trips.

## *2.2. Subjective Norm*

The subjective norm is based on normative beliefs (social pressure). It is the judgment that people make about what the individual should do and his motivation to agree with these people (parents, friends, reference groups, culture, and public institutions). The opinion of these groups may be decisive in the option to use the bicycle for commuting.

The larger the network of relationships of the individual, the greater his need for approval, not only from the family, but also from other groups in society. The opinion of these groups can be determinant in the choice to use the bicycle as a means of transport. Positive subjective norms (Heinen et al, 2011; Forward and Eriksson, 2011) and the perception that cycling is normal (Xing et al, 2010) are associated with a greater use of bicycles.

Studies by different researchers confirmed the importance in subjective norms in the choice of cycling for commuting (Bruijn et al, 2009; de Geus, 2008). Dill and Voros (2007) provide evidence that, if co-workers use a bicycle, it is more likely that an individual also opts for the bike. Furthermore, if employers offer financial incentives for cyclists (which can be seen as approval for the use of bicycles), there is a greater chance that employees will use the bike (de Geus et al, 2008).

In general, people whose friends and relatives use (or encourage the use of) the bike are more likely to also adopt the bicycle as a mode of transport (Titze et al , 2008; de Geus et al, 2008).

## *2.3. Perceived Behavioral Control*

The behavioral control stems from the beliefs of control and reflects the expectation of an individual to be able to overcome any obstacle to perform certain behavior. In the case of cycling, the obstacles are the factors that may be considered as barriers to adopt the bicycle as a mode of transport.

The literature presents a large set of factors that individuals may consider possible barriers to cycling, including: travel time, stress, too much traffic, perception of insecurity, lack of physical fitness, personal factors (eg, lack of time), night travel, inconvenience, lack of infrastructure for cyclists, climate and topography (Gatersleben and Appleton, 2007; de Geus et al, 2008; Miller, 2007; Heinen, 2010; Heredia and Monzon, 2010; Muñoz et al , 2013).

This article focuses on two of the concepts of the Theory of Planned Behavior: Attitude and Perceived Behavioral Control.

## **3. Methodology**

Data collection for this research was conducted in a public college in the city of São José do Rio Preto, in the state of São Paulo. This city is located 400 northwest of the state capital, has a population of around 435,000 inhabitants and an average annual temperature of 23.6 °C.

In order to assess the attitude and perception of barriers of students, faculty and staff regarding the use of bicycles as a mode of transport for commuting to college, a questionnaire, based on the dimensions of the Theory of Planned Behavior, was prepared. The questionnaire was sent via email to undergraduate and graduate students, administrative staff, outsourced staff and faculty of the institution.

### *3.1. Assessment of the attitude towards the use of bicycles for commuting*

The first part of the questionnaire addressed the attitude toward the use of bicycles for commuting by means of 12 statements related to beliefs about the use of this mode of transport (shown in Table 1). These statements were

evaluated by respondents using a 7 points Likert scale, ranging from "strongly agree" (coded as 7) to "strongly disagree" (coded as 1). For items that indicate a negative attitude towards cycling (items 9, 10 and 11), the coding was reversed.

The importance that individuals attach to these beliefs was assessed by a scale ranging from "Very Important" (coded as 7) to "Totally Unimportant" (coded as 1).

The general attitude of respondents regarding the use of the bicycle for commuting to college was assessed by the sum of beliefs scores multiplied by the importance attributed to these beliefs.

Table 1 – Beliefs about cycling

|   |
|---|
| <p>How much do you agree with the following statements?</p> <p>1 - If I use the bike for commuting I will help to improve the environment</p> <p>2 - Using the bike for commuting will benefit to my health</p> <p>3 - Transport by bike is cheap</p> <p>4 - Can better observe the landscape around me</p> <p>5 - It is easy to park a bike in college</p> <p>6 - If I use the bike for commuting, I will get to college faster</p> <p>7 - Cycling brings prestige to my image</p> <p>8 - Cycling requires too much effort</p> <p>9 - If I commute by bike I may get involved in traffic accidents</p> <p>10 - If I commute by bike I may be robbed or assaulted</p> <p>11 – I will be exposed to sun and rain</p> <p>12 - Gives a feeling of independence</p> |
|---|

### 3.2. Assessment of the perception of barriers for using the bicycle

The assessment of barriers (perceived behavioral control) is a person’s own evaluation of the possibility of overcoming any obstacle to use the bicycle for commuting.

The literature presents a large set of factors that individuals may consider possible obstacles or barriers to cycling, including: travel time, stress, too much traffic, perception of insecurity, lack of physical fitness, personal factors (eg, lack of time), night travel, inconvenience, lack of infrastructure for cyclists, climate and topography (Gatersleben and Appleton, 2007; de Geus et al, 2008; Miller, 2007; Heinen, 2010; Heredia and Monzon, 2010; Muñoz et al , 2013).

For this research, respondents were asked about their perception of barriers (control beliefs) by means of 6 statements (Table 5). These statements were evaluated by respondents using a 7 points Likert scale, ranging from "strongly agree" (coded as 7) to "strongly disagree" (coded as 1). For items that indicate a negative perception of the possibility of overcoming the obstacle (items 1 and 5), the coding was reversed.

Table 5 – Control beliefs about commuting by bicycle

|   |
|---|
| <p>1. I am not able to commute by bicycle because the city does not have an adequate cycling infrastructure.</p> <p>2. Traffic safety in the city is not an obstacle for me to commute by bicycle</p> <p>3. The distance I live from the Campus, allows me to use the bicycle as a mode of transport.</p> <p>4. I have enough skill (physical ability, experience) to use the bike for commuting</p> <p>5. The city topography (slopes) is an aspect that prevents me from using the bike to commute.</p> <p>6. The city's climate does not prevent me from using the bicycle for commuting</p> |
|---|

The importance that individuals attach to these beliefs was assessed by a scale ranging from "Very Important" (coded as 7) to "Totally Unimportant" (coded as 1).

The control belief regarding the use of the bicycle for commuting to college was assessed by the sum of beliefs scores multiplied by the importance attributed to these beliefs (see Equation 1).

The final part of the questionnaire asked about the respondent's personal characteristics: gender, age, occupation in college, mode of transport used for commuting, possession of automobile, motorcycle or bicycle and time usually spent for commuting. This information was used to stratify respondents into different profiles.

#### 4. Results

The college, where data was collected, has a population of around 900, including faculty, students and staff. A sample of 288 completed questionnaires was obtained (sampling error less than 5% and degree of confidence of 95%). Table 3 shows the general characteristics of the respondents.

Table 3 – General characteristics of the respondents

|                                |       |                               |       |
|--------------------------------|-------|-------------------------------|-------|
| <b>Age (years)</b>             |       | <b>Gender</b>                 |       |
| Less than 18:                  | 1,1%  | Masculine:                    | 55,8% |
| 18 to 24                       | 41,1% | Feminine:                     | 44,2% |
| 25 to 34                       | 32,6% | <b>Occupation in college:</b> |       |
| 35 to 44                       | 13,7% | Under graduate student:       | 70,5% |
| 45 to 64                       | 11,6% | Graduate student:             | 13,7% |
| More than 64                   | 0,0%  | Faculty:                      | 10,5% |
| <b>Commuting time</b>          |       | Outsourced staff:             | 1,1%  |
| Less than 10 minutes:          | 19,0% | Administrative staff:         | 4,2%  |
| 10 to 20 minutes:              | 42,1% | <b>Has a motorcycle</b>       |       |
| 20 to 40 minutes:              | 20,0% | Yes:                          | 38,9% |
| More than 40 minutes:          | 18,9% | No:                           | 61,1% |
| <b>Mode used for commuting</b> |       | <b>Has a bicycle</b>          |       |
| Car:                           | 50%   | Yes:                          | 49,5% |
| Motorcycle:                    | 21%   | No:                           | 50,5% |
| Bus:                           | 27%   | <b>Has a car</b>              |       |
| Bicycle:                       | 0%    | Yes:                          | 88,4% |
| Walking:                       | 2%    | No:                           | 11,6% |

##### 4.1 Attitude regarding the use of the bicycle for commuting to college

The quality of the scale used in this study was evaluated by its degree of reliability by means of Cronbach's  $\alpha$ , which measures the similarity between the responses and what the scale intends to measure (in this case, the attitude). The scale to measure the attitude (items shown in Table 1) resulted in  $\alpha=0.707$ . This value indicates good consistency and adequacy of the scale.

The respondents' beliefs were assessed by 12 items, with responses ranging from 1 to 7 (higher values indicating a more favorable view of bicycle commuting). The importance of these beliefs was also assessed on a scale ranging from 1 to 7 (with higher values indicating greater importance). Table 4 shows the average values (and the standard deviation) of the beliefs scores.

The second column in Table 4 shows the scores of the 12 beliefs. Beliefs with more positive assessment (values closer to 7) are: bicycle use benefits health (6.20), preserves the environment (6.08) and permits saving money (6.00). Beliefs with negative assessment (values closer to 1) are: exposure to sun and rain (2.54) and the risk of getting involved in traffic accidents (2.88).

The third column in Table 4 lists the importance of the beliefs when the respondent chooses a mode of transport for commuting. Most of the items were considered important, (with values above 4.0), and safety (avoiding being exposed to traffic accidents) was the most important (value = 5.99). On the other hand, respondents did not consider it important that the mode of transport used to commute to college might harm their image (value = 2.61). This was the only belief with importance below 4.0.

Table 4 – Scores of beliefs and attitudes regarding using the bicycle for commuting

|                                       | Belief      | Importance of belief | Attitude regarding commuting by bicycle |
|---------------------------------------|-------------|----------------------|---|
| Improves the environment              | 6.08 (1.42) | 5.38 (1.58)          | 32.70 (13.13)                           |
| Health benefits                       | 6.20 (1.34) | 5.37 (1.56)          | 33.30 (12.73)                           |
| Save money                            | 6.00 (1.46) | 5.59 (1.49)          | 33.53 (13.11)                           |
| Can better observe the landscape      | 4.69 (1.74) | 4.42 (1.71)          | 20.74 (13.22)                           |
| Difficult to find place for parking   | 3.87 (2.09) | 5.40 (1.62)          | 20.87 (12.68)                           |
| Get to college faster                 | 3.56 (1.97) | 5.25 (1.54)          | 18.72 (13.42)                           |
| Prestige to my image                  | 5.88 (1.51) | 2.61 (1.84)          | 15.38 (8.98)                            |
| Requires too much effort              | 4.07 (1.94) | 4.18 (1.66)          | 17.03 (9.23)                            |
| May get involved in traffic accidents | 2.88 (1.60) | 5.99 (1.18)          | 17.24 (10.03)                           |
| May be robbed or assaulted            | 3.67 (1.84) | 5.81 (1.37)          | 19.82 (11.13)                           |
| I will be exposed to sun and rain     | 2.54 (1.47) | 5.37 (1.50)          | 13.62 (8.77)                            |
| Feeling of independence               | 4.14 (1.95) | 5.46 (1.56)          | 22.64 (14.06)                           |

Average (standard deviation)

According to the TPB, the attitude is obtained by multiplying the belief score by the importance score. Thus, the highest possible value for the attitude in relation to each item is  $7 \times 7 = 49$  (totally favorable to bicycle use), and the lowest possible value is  $7 \times 1 = 7$  (totally against bicycle use). The average value (indicating a point of indifference) is  $(49 - 7) / 2 = 21.0$ . These results are shown in the right hand column of Table 4.

The respondents have a positive attitude to cycling (values above 21.0) for four aspects: environmental benefits, health benefits, economy and feeling of independence. For all the other aspects, the attitude is negative (values below 21.0).

For evaluating the overall attitude of each respondent regarding bicycle use for commuting the sum of ratings of all the items was taken. Thus, the largest possible value for the overall assessment of attitude is  $(12 \times 49) = 588$  (fully embraces bicycle use) and the lowest possible value is  $(12 \times 1) = 12$  (totally against the use of bicycles). The average value is 271.1 (with standard deviation equal to 70.8). For this analysis, the respondents were divided in 5 groups as described in Table 5.

Table 5 - General attitudes regarding the use of bicycles

| Attitude score | Attitude      | Number of respondents |
|----------------|---------------|-----------------------|
| 12 to 127      | Very negative | 6 (2.0%)              |
| 128 to 242     | Negative      | 99 (34.4%)            |
| 243 to 357     | Neutral       | 150 (52.1%)           |
| 358 to 472     | Positive      | 33 (11.5%)            |
| 473 to 588     | Very positive | 0 (0.0%)              |

Most respondents (63.6%) revealed a neutral or positive attitude to cycling and none could be included in the very positive group. This result is not surprising because another survey, using a different methodology, also found that most individuals can be considered as potential cyclists who do not have a negative attitude towards cycling (Sanches and Ferreira, 2012).

#### 4.2. Perceived barriers regarding the use of the bicycle for commuting

The scale used in this study for evaluating the behavioral control attained a Cronbach's  $\alpha$  equal to 0,598, which indicates an adequate degree of consistency. Table 6 shows the average values (and the standard deviation) of the behavioral control scores.

Table 6 – Scores of beliefs and behavioral control for using the bicycle for commuting

|                          | Barrier     | Importance of barrier | Behavioral Control |
|--------------------------|-------------|-----------------------|--------------------|
| Lack of Infrastructure   | 2,68 (2,18) | 6,34 (1,02)           | 16,96 (12,75)      |
| Lack of Safety           | 3,84 (2,09) | 6,35 (0,96)           | 24,40 (14,10)      |
| Distance                 | 4,04 (2,28) | 5,88 (1,20)           | 23,74 (14,64)      |
| Skill / Physical fitness | 4,42 (2,19) | 5,93 (1,02)           | 26,21 (14,78)      |
| Slopes                   | 3,97 (1,93) | 5,75 (1,21)           | 22,84 (12,35)      |
| Climate                  | 4,18 (2,01) | 5,66 (1,28)           | 23,68 (13,42)      |

Average (standard deviation)

According to the TPB, the behavioral control is evaluated by multiplying the barrier score by the importance score, as shown in the right hand column of Table 6. The highest possible value for the control is 49 (complete control – weak barrier), and the lowest possible value is 7 (no control at all – strong barrier). The average value is 21.

As can be seen in the second column of Table 6, the respondents consider that lack of adequate cycling infrastructure as the strongest barrier for using the bike. Lack of safety (which is associated with the absence of infrastructure) and slopes are other strong obstacles for commuting by bicycle in the city.

Lack of infrastructure and safety are also the most important barriers, with score values above 6.0 (third column of Table 6). The least important obstacle for commuting by bike is the climate (being exposed to sun and rain) with score 5.66, which is still rather high (considering that the highest possible importance value is 7).

The right hand column of Table 6 shows the overall behavioral control scores. The control concerning lack of infrastructure is below the average (below 21.0). All other behavioral control scores are above the average (but only slightly).

For evaluating each individual's overall perception of behavioral control, the sum of ratings of all items was taken. Thus, the largest possible value for the overall assessment of perceived behavioral control is  $(6 \times 49) = 294$  and the lowest possible value is  $(6 \times 1) = 6$ . The average value is 138.2 with standard deviation equal to 38.7. For this analysis, the respondents were divided in 5 groups as described in Table 7.

Table 7 - Overall perception of behavioral control

| Behavioral Control Scores | Perception of Control | Perception of Barriers | Number of respondents |
|---------------------------|-----------------------|------------------------|-----------------------|
| 6 to 64                   | Very weak             | Very strong            | 7 (2.4%)              |
| 65 to 121                 | Weak                  | Strong                 | 95 (33.0%)            |
| 122 to 179                | Average               | Average                | 138 (47.9%)           |
| 180 to 236                | Strong                | Weak                   | 48 (16.7%)            |
| 236 to 294                | Very strong           | Very weak              | 0 (0.0%)              |

Almost half of the respondents (47.9%) have an average perception of behavioral control and the second largest group (33.0%) is composed of those who declare having a weak perception of control. It is significant that no respondent perceive very weak barriers for cycling.

4.3. Attitudes and perception of barriers

Table 8 and Figure 1 show the effects of attitudes on the perception of behavioral control for commuting by bicycle (the lower the score of behavioral control, the greater the perception of barriers).

Table 8 – Average behavioral control scores according to attitude

| Aspects                  | Attitude      |          |         |          |
|--------------------------|---------------|----------|---------|----------|
|                          | Very negative | Negative | Neutral | Positive |
| Lack of Infrastructure   | 19.3          | 16.9     | 16.9    | 14.6     |
| Lack of Safety           | 28.3          | 26.9     | 25.5    | 28.5     |
| Distance                 | 14.2          | 21.2     | 24.3    | 23.3     |
| Skill / Physical fitness | 15.2          | 24.1     | 24.7    | 29.3     |
| Slopes                   | 25.5          | 22.6     | 23.2    | 25.2     |
| Climate                  | 20.3          | 25.7     | 22.3    | 28.6     |
| Behavioral Control Score | 118.3         | 137.5    | 136.9   | 149.6    |

Table 8 shows that the negative and the neutral groups are not very different in their perception of barriers for cycling. The individuals who have a positive attitude to cycling perceive weaker barriers (they have stronger behavioral control). In contrast, a negative attitude is associated with the perception of stronger barriers.

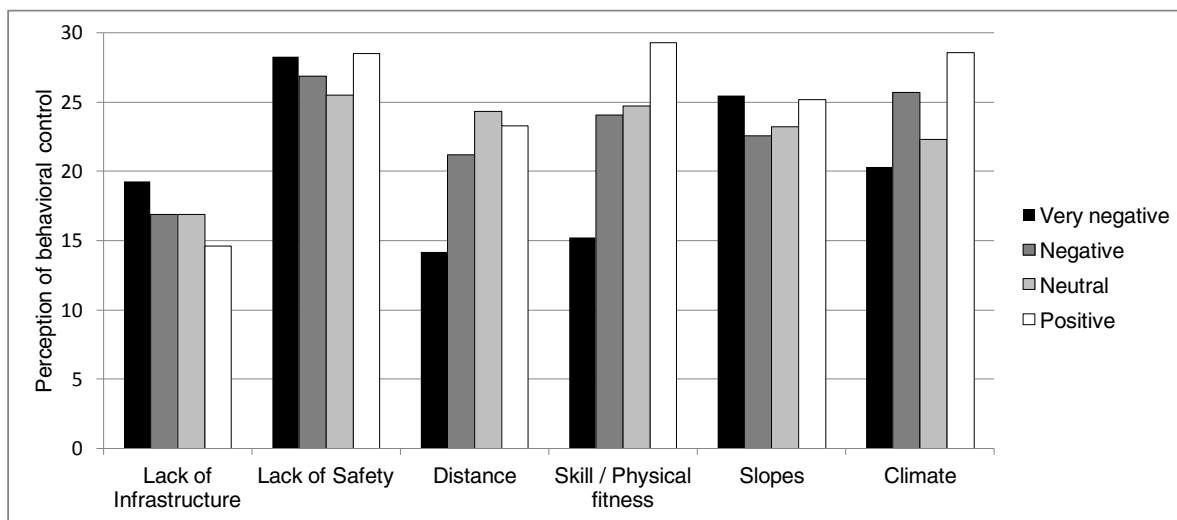


Fig. 1 - Perception of behavioral control according to attitude

Figure 1 shows that the lack of infrastructure is a barrier for all the groups (it is the aspect that presents the lowest behavioral control scores). Surprisingly, those who have a negative attitude towards cycling reveal high control scores for lack of infrastructure and safety. In general, a positive attitude is associated with high control (weaker perception of barriers for cycling).



## 5. Conclusions

The aim of the present research was to examine whether an individual's attitude towards cycling influences his perception of barriers (perceived behavioral control) for cycle commuting. Attitudes and perceived behavioral control were measured using psychological constructs, following the Theory of Planned Behavior.

The attitudes were assessed by means of 12 statements related to beliefs about the use of this mode of transport. The results indicate that the respondents have a positive attitude to cycling for four aspects: environmental benefits, health benefits, economy and feeling of independence. For the other eight aspects (better observing the landscape, parking, speed, prestige, effort, risk of accidents, risk of being assaulted and exposure to sun and rain) the general attitude is negative.

Five groups of people could be identified regarding their attitude: very negative, negative, neutral, positive and very positive. Most respondents (63.6%) revealed a neutral or positive attitude to cycling and none could be included in the very positive group.

Respondents were asked about their perception of barriers (control beliefs) by means of 6 statements related to obstacles that might deter them from cycling: lack of infrastructure, lack of safety, distance, skill, slopes and climate. The main deterrent against cycling was lack of adequate cycling infrastructure. Lack of safety (which is associated with the absence of infrastructure) and slopes are other strong obstacles for commuting by bicycle in the city. To attract more people to cycling and in particular to cycle commuting, overcoming these barriers should therefore be included as measures in the cycling mobility strategy of local administrations and organizations. Particularly, improving road infrastructure for cyclists can make people feel more safe and comfortable and can be an effective strategy to increase the share of bicycle commuters.

Concerning the overall perception of behavioral control, five groups were defined: very weak, weak, average, strong and very strong perception of behavioral control (the lower the behavioral control, the greater the perception of barriers). Almost half of the respondents (47.9%) have an average perception of behavioral control and the second largest group (33.0%) is composed of those who declare having a weak perception of control. No respondent perceive very weak barriers for cycling.

The groups with negative and the neutral attitude toward cycle commuting are not very different in their perception of barriers for cycling. The individuals who have a positive attitude to cycling perceive weaker barriers (they have stronger behavioral control). In contrast, a very negative attitude is associated with the perception of stronger barriers.

It is important to point out that this study has two limitations that require further analysis: (1) The sample consisted of students from only one Brazilian medium-sized city which presents conditions of topography and climate suitable for cycling and a low bicycle modal share. It is necessary to analyze the behavior of students from cities with other characteristics and (2) the sample was relatively small compared to the number of students in the city and, moreover, participation in the survey was voluntary and therefore the obtained sample is not random. Different results could possibly be obtained with larger samples and in other contexts.

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## References

- Abrahamse, W.; Steg, L.; Gifford, R.; Vlek C. (2009) Factors influencing car use for commuting and the intention to reduce it: A question of self-interest or morality?, *Transportation Research Part F* 12, p. 317–324.
- Ajzen, I. (1991). The theory of planned behavior, *Organizational Behavior and Human Decision Processes* 50, p. 179-211.
- Anable, J. (2005) 'Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behaviour segments using attitude theory, *Transport Policy* 12, p. 65–78.
- Bamberg, S.; Ajzen, I.; Schmidt, P. (2003). Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action, *Basic and Applied Social Psychology* 25, p. 175-188.

- Brasil, Ministério das Cidades (2007) *Caderno Referência para a elaboração do Plano de Mobilidade por Bicicleta nas Cidades*.
- Bruijn, G.; Kremers, S.; Singh, A.; Putte, B.; Mechelen, W. (2009) Adult Active Transportation - Adding Habit Strength to the Theory of Planned Behavior, *American Journal of Preventive Medicine* 36(3), p.189–194.
- Chen, C.; Chau, W. (2011) Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit, *Transportation Research Part F* 14, p. 128–137.
- de Geus, B.; Bourdeaudhuij, C.; Meeusen, R. (2008) Psychosocial and environmental factors associated with cycling for transport among a working population, *Health Education Research* Vol.23 no.4, p. 697–708.
- Dickey-Griffith, M. (2009) *The choice to cycle: The efficacy of the theory of planned behavior in transportation decisions*, Dissertation Haverford College, Philadelphia, PA United States
- Dill, J.; Voros, K. (2007) Factors affecting bicycling demand: Initial survey findings from the Portland region, *TRB 2007 Annual Meeting*.
- Eriksson, L.; Forward, S. (2011) Is the intention to travel in a pro-environmental manner and the intention to use the car determined by different factors? *Transportation Research Part D*, Vol. 16, p. 372-376.
- Francis, J.; Eccles, M.; Johnston, M.; Walker, A.; Grimshaw, J.; Foy, R.; Kaner, E.; Smith, L.; Bonetti, D. (2004) *Constructing questionnaires based on the Theory of Planned Behaviour - A manual for health services researchers*, Centre for Health Services Research - University of Newcastle, United Kingdom.
- Gatersleben, B.; Appleton, K. (2007) Contemplating cycling to work: attitudes and perceptions in different stages of change, *Transportation Research Part A*, 41(4), p. 302-312.
- Heinen, E. et al (2010) Commuting by Bicycle: An Overview of the Literature, *Transport Reviews* 30:1, p. 59-96.
- Heinen, E.; Maat, K.; van Wee, B. (2011) The role of attitudes toward characteristics of bicycle commuting on the choice to cycle to work over various distances, *Transportation Research Part D*, Vol. 16, p. 102–109.
- Heredia, A.; Monzon, A. (2010) Cyclists' travel behaviour, from theory to reality, *12th WCTR*, Lisbon, Portugal
- Miller, B. (2007) *Campus commuting: barriers to walking and bicycling use in a university town*, Master Thesis Clemson University, South Carolina, United States
- Muñoz, B.; Monzon, A.; Lois, D. (2013) Cycling habits and other psychological variables affecting commuting by bicycle in the city of Madrid, *TRB 2013 Annual Meeting*.
- Sanches, S.; Ferreira, M. (2012) Identificação de potenciais ciclistas usando estatística multivariada, *XVII PANAM – Congresso Panamericano de Engenharia de Trânsito, Transporte y Logística*, Santiago
- Titze, S.; Strongegger, W.; Janschitz, S.; Oja, P. (2008) Association of built-environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers, *Preventive Medicine* 47, p. 252–259
- Willis, D.; Manaugh, K.; El-Geneidy, A. (2013) Cycling under influence: Summarizing the influence of attitudes, habits, social environments and perceptions on cycling for transportation, *TRB 2013 Annual Meeting*
- Xing, Y.; Handy, S.; Mokhtarian, P. (2010) Factors associated with proportions and miles of bicycling for transportation and recreation in six small US cities, *Transportation Research Part D*, Vol. 15, p. 73-81.