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Perception of barriers for the use of bicycles

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Abstract

   The objective of the research described in this article was to evaluate the perception of a group of individuals with respect to barriers that may hinder the use of bicycles for commuting. Data collection was carried out with 380 college students in three Brazilian cities. In order to assess the perception of barriers, a questionnaire, based on the dimensions of the Theory of Planned Behavior, was prepared. The selection of the barriers to be used in the survey was made after a review of several papers published in referenced periodicals and included: lack of cycling infrastructure, lack of safety, distance to be travelled, physical fitness, slopes and climate. The results show that the strongest perceived barrier (smallest behavioral control) in all three cities is the lack of dedicated cycling infrastructure. This result emphasizes how important an adequate cycling network is for encouraging and increasing the use of bicycles for commuting. The analysis of the size of cities versus the perceived behavioral control revealed that the larger the city the lower the level of behavioral control (stronger barriers).

1. Introduction

   In recent decades, the bicycle has played a more and more important role in transport policies due to its environmental benefits, both for traffic and for cyclists' health. It is a non-polluting, flexible, economical vehicle and a big booster for the user's health. The inclusion of bicycles as a regular mode of transport in urban

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displacements must be addressed considering the concept of Sustainable Urban Mobility (Brazilian Ministry of Cities, 2007).

From this perspective, the theme of sustainable mobility appears among the top concerns of public policies related to urban transport and should be integrated with other urban policies, with the ultimate goal of prioritizing the citizens and the fulfillment of their desires and needs, improving the general conditions of displacements in cities.

In this scenario, Brazilian Government Agencies, responsible for the urban planning and transport sectors, have played an important role in promoting sustainable urban mobility. Many cities are now investing in cycling projects, encouraged mainly by resources made available by the Ministry of Cities' Program Bicycle Brazil (Brazil, 2007). This program promotes the bicycle as a sustainable mode of transport, which helps reducing the number of motor vehicles in cities, preserving the environment, the health of the population and influencing the economy.

However, this government effort by itself may not be enough to ensure greater participation of the bicycle in the modal split of Brazilian cities. It is also necessary to identify the individual's perception about the barriers regarding the use of bicycles 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 (e.g., lack of time), necessity of traveling at night, inconvenience, lack of adequate infrastructure for cyclists, climate factors and topography.

The success of policies and campaigns to reduce car use depends largely on understanding the factors that influence an individual's modal choice. Usually, however, the proposals to encourage the use of transit and non-motorized transportation, have been based on informal conceptualizations, designed without prior research and focused mostly in providing information about the negative consequences of using automobiles.

Such information is not generally sufficient to change behaviors. It has been already verified that the reason why an individual decides to use the automobile has little to do, for example, with their knowledge about the environmental impacts of the extensive use of cars (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).

In many countries, where bicycles are more frequently used, the university students are one of the groups of people who use bicycles more frequently. This does not happen in Brazil where most students use cars for commuting to college.

What encouragements would make Brazilian university students commute to college by bicycle? What are the obstacles they perceive not to adopt this mode of transport? For the bicycle to be more frequently used, it is necessary to understand their perceptions of the barriers and obstacles that prevent cycling.

Several models which have been proposed to analyze the complex interaction between the individuals' behavior and their personal characteristics 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 objective of this paper is to describe a survey that has been developed with a sample of students of public colleges in Brazilian medium-sized cities, in order to identify the barriers that may hinder the use of bicycles as a mode of transport, using the constructs of the Theory of Planned Behavior.

2. The Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is one of the most important theories concerning the investigation of human behavior. It was proposed by social psychologist Icek Ajzen in 1985. TPB has been widely used and has shown good results for research in several areas of knowledge, including transportation.

This theory argues that a behavior is determined by the intention to adopt the behavior, which depends on a value judgment based on beliefs that the individual possesses (Ajzen, 1985).

The intention plays a key role in the TPB, because it assembles the motivational elements that influence behavior. The intention indicates how much the individual is willing to try and how much effort he is willing to make in order to perform an action (Lopez Jr., 2004).

Three prior independent determinants comprise the intention: (1) The attitude toward the behavior (the individual's assessment of how beneficial the behavior can be), (2) Subjective norms, which correspond to the

perceived social pressures to adopt or not to adopt the behavior and (3) The perceived behavior control, which is the perceived ability to perform the behavior (Ajzen, 1991).

2.1. Attitude towards the behavior

The attitude of an individual in relation to a behavior can be predicted from the knowledge about his personal beliefs and the intensity of these beliefs. In the TPB model, the attitudes are described by the beliefs related to consequences of the behavior in question, multiplied by the importance of these consequences, according to the perception of the individual (Ajzen, 1991). Thus, the attitude of an individual is based on their behavioral beliefs (what the individual believes will happen if they perform a certain behavior) and on the consequences (positive or negative) of adopting this behavior.

Dill and Voros (2007) have shown that having a positive attitude towards cycling increases the likelihood of using this mode of transport for utilitarian trips (like commuting to college). Heinen et al (2011), in a survey conducted in the Netherlands, concluded that the attitude towards the benefits of cycling (for example, convenience, low cost, health benefits) is an important factor for the choice of the bicycle. Also, these researchers found that individuals who commute longer distances usually have a more positive attitude to cycling than individuals who make shorter trips.

2.2. Subjective norms

The second determinant of behavioral intention refers to the individual's perception of social pressures regarding the behavior in question. These are the influences caused by social pressure from parents, friends, reference groups, culture and public institutions on the behavior of individuals. This determinant can be understood as the opinions of others that the individual considers important in relation to a particular behavior (Ajzen, 1991).

The larger the individual's network of relationships, the greater their need for approval, not only by the family but also by the other groups in society. The more positive the subjective norms related to the behavior, the greater the person's intention to act, and, hence, the more likely it is that this person presents the behavior in question. On the other hand, the disapproval of a behavior, for example by the group of friends, may be extremely painful and undesirable for an individual (Kerby, 1970).

2.3. Perceived behavioral control

The perceived control over the behavior is the individual's perception of how difficult (or easy) it is to perform the behavior, considering the resources available and their ability to perform it. It refers to the perception of the presence of factors that may facilitate or hinder the behavior. The control beliefs combined with the power of each control factor determine the perceived behavioral control that will prevail (Ajzen, 2006).

In the case of this research, it is the perception of the facilities and barriers for cycling that makes the adoption of the bicycle for commuting to college easier or more difficult. For the students, an adequate cycling infrastructure and facilities, such as bike racks, bathrooms and closets are necessary for the use of the bicycle. If these facilities are available, the option for the bicycle will be easier.

It should be pointed out that the perception of facilities and barriers varies for person to person. Also, what one person perceives may be substantially different from the objective reality. Thus, it is assumed that the behavior is based on an individual's perception of reality, not on the reality itself (Robbins, 2005).

This article focuses on only one concept of the Theory of Planned Behavior: the Perceived Behavioral Control (perception of barriers).

3. Methodology

Data collection for this research was conducted in four public and private colleges located in Brazilian medium cities of different sizes (Table 1). One common characteristic of these cities is that they have a low bicycle modal share and only a few kilometers of dedicated bicycle infrastructure.

Table 1. Cities where data was collected

City	Population
Campo Grande, MS	830,000
São José do Rio Preto, SP	435,000
São Carlos, SP	220,000

In order to assess the perception of barriers 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 students of the institutions. It was emailed to 1,200 undergraduate students, and 380 completed the form.

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 a 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 selection of the barriers to be included in the survey was made after a review of several papers published in referenced periodicals. 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).

Respondents were asked about their perception of barriers (control beliefs) by means of 6 statements (Table 2). These statements were evaluated by respondents using a seven-point 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. Thus, higher values indicate a positive perception of control and so a weak barrier; lower values indicate a negative perception of control and so, a strong barrier.

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.

Table 2 – Control beliefs about commuting by bicycle (perception of barriers)

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

The final part of the questionnaire asked about the respondent's personal characteristics: gender, age, 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

Table 3 shows the general characteristics of the respondents.

Table 3. Profile of respondents

City	Gender
Campo Grande: 38 (9.4%)	Male: 244 (64.2%)
São José do Rio Preto: 288 (71.5%)	Female: 136 (35.8%)
São Carlos: 54 (13.4%)	
Age (years)	Mode of transport used for commuting
< 18: 6 (1.6%)	Car - driver: 159 (41.8%)
18 to 24: 255 (67.1%)	Car – rider: 16 (4.2%)
25 to 34: 79 (20.8%)	Bus: 112 (29.5%)
35 to 44: 23 (6.1%)	Walking: 14 (3.7%)
45 to 64: 17 (4.5%)	Motorcycle: 72 (18.9%)
> 65: 0 (0.0%)	Bicycle: 7 (1.8%)

The scale used in this study for evaluating the behavioral control attained a Cronbach's α equal to 0,598, which indicates an adequate degree of consistency. Table 4 shows the average values (and the standard deviation) of the behavioral control scores.

Table 4.Control beliefs (barriers) for using the bicycle for commuting

	Average Control Belief	Average Importance of Belief	Average Behavioral Control
Lack of Infrastructure	2,60 (2.16)	6,33 (1.04)	16.45 (12.46)
Lack of Safety	3,83 (2,11)	6,34 (0,98)	24,27 (14,22)
Distance	4,04 (2,28)	5,87 (1,22)	23,75 (14,74)
Physical fitness	4,43 (2,20)	5,95 (1,03)	26,34 (14,91)
Slopes	3.96 (1.93)	5.73 (1.23)	22.66 (12.25)
Climate	4,21 (2,01)	5,67 (1,29)	23,88 (13,47)

According to the TPB, the behavioral control is evaluated by multiplying the control belief score by the importance score, as shown in the right hand column of Table 4. The highest possible value for the behavioral control is 49 (complete control), and the lowest possible value is 1 (no control at all). The average value is 24.0.

As it can be seen in the second column of Table 4, the respondents consider the lack of adequate cycling infrastructure to be the strongest barrier for using the bicycle (lowest value of control). Lack of safety (which is associated with the absence of infrastructure) and slopes are also 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 4). The least important obstacle for commuting by bicycle is the climate (being exposed to sun and rain) with score 5.67, which is still rather high (considering that the highest possible importance value is 7).

The right hand column of Table 4 shows the overall behavioral control scores. Lack of safety and physical fitness are the only two scores above the average. All the other behavioral control scores are below the average. Figure 1 shows the relationship between beliefs and their respective importance. In quadrant I (control beliefs below average and importance above average) there are three items (infrastructure, safety and distance). The other three beliefs are in quadrant II (control and importance above average).
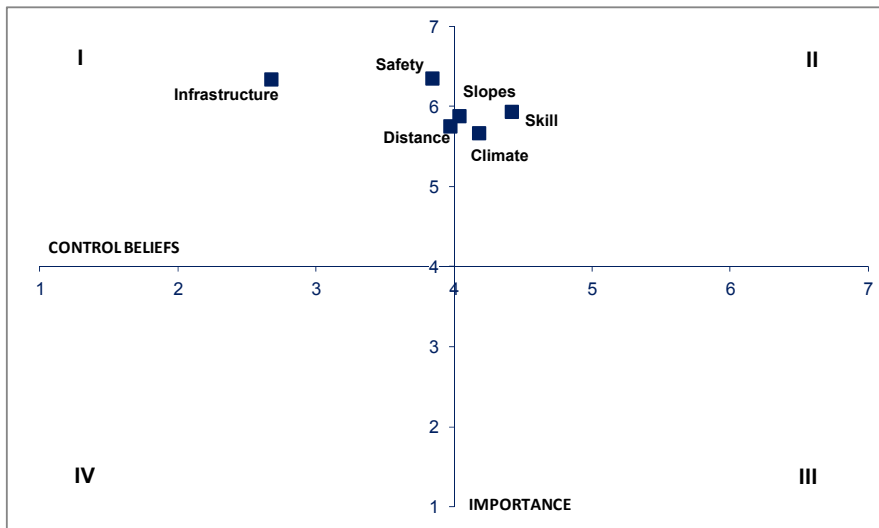
Fig. 1. Relationship between control beliefs and importance

4.1. *Overall rating of perceived behavioral control for each individual*

For evaluating the overall perceived behavioral control of each individual, the sum of ratings of all the items was taken. Thus, the largest possible value for the overall assessment of perceived behavioral control is (6 x 49) = 294 (strong control) and the lowest possible value is (6 x 1) = 6 (week control). The average value attained for all the respondents was 137 (standard deviation = 37). For this analysis, the respondents were divided in 5 groups as described in Table 5.

Table 5. Overall perception of behavioral control

Behavioral Control Scores	Perception of Control	Perception of Barriers	Number of respondents
6 to 64	Very weak	Very strong	9 (2.4 %)
65 to 121	Weak	Strong	134 (35.3%)
122 to 179	Average	Average	178 (46.8%)
180 to 236	Strong	Weak	59 (15.5%)
236 to 294	Very strong	Very weak	0 (0.0%)

Almost half of the respondents (46.8%) have an average perception of behavioral control and the second largest group (35.2%) is composed of those who claim to have a weak perception of control. It is significant that no respondent perceives very weak barriers for cycling.

4.2. *Difference of barriers perception among cities*

As described earlier in this paper, the highest possible value for the behavioral control for each barrier is 49 (complete control), and the lowest possible value is 1 (no control at all). For the analysis of differences among cities, the categories shown in Table 6 were adopted.

Table 6. Categories of Behavioral Control Perception for each barrier

Behavioral Control Scores	Perception of Control
1 to 9	Very weak
10 to 18	Weak
19 to 31	Average
32 to 40	Strong
41 to 49	Very strong

Table 7 and Figure 2 show a comparison of the perceptions of behavioral control revealed by respondents of the different cities and show that there are differences of behavioral control perception.

Table 7.Average behavioral control perception in the three cities

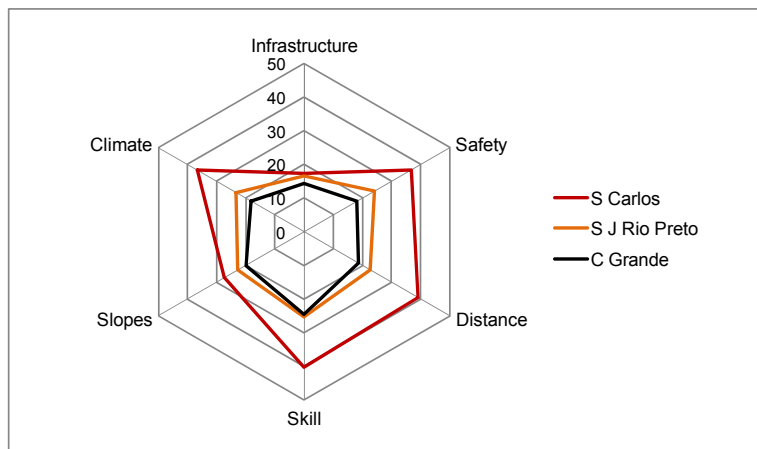|	S Carlos	S J Rio Preto	Campo Grande
Infrastructure	17.3	16.6	14.3
Safety	36.7	24.0	18.0
Distance	39.2	22.6	18.6
Skill	40.3	25.2	24.5
Slopes	27.3	22.8	20.0
Climate	36.6	23.3	18.2
Overall behavioral control	197.3	134.5	113.7

Fig. 2.Behavioral control perception in the three cities

It is interesting to notice that Lack of Cycling Infrastructure is the strongest barrier in all three cities (behavioral control scores are all below 18). In São Carlos, Infrastructure is the only barrier for which behavioral control is weak or very weak (score = 17.3). Therefore, lack of dedicated cycling infrastructure is the strongest barrier that discourages the use of bicycles as a modal option for commuting to campus in this city. The second strongest barrier in São Carlos is Slopes, but, in this case, the level of behavioral control is considered average. For all the other barriers, the respondents have strong or very strong behavioral control. For São José do Rio Preto and Campo Grande, the scores for all the barriers (except for infrastructure) fall in the average and strong ranges.

Figure 3 displays the relationship between the city's population and the behavioral control scores and it is possible to verify that the bigger the city, the smaller the behavioral control.
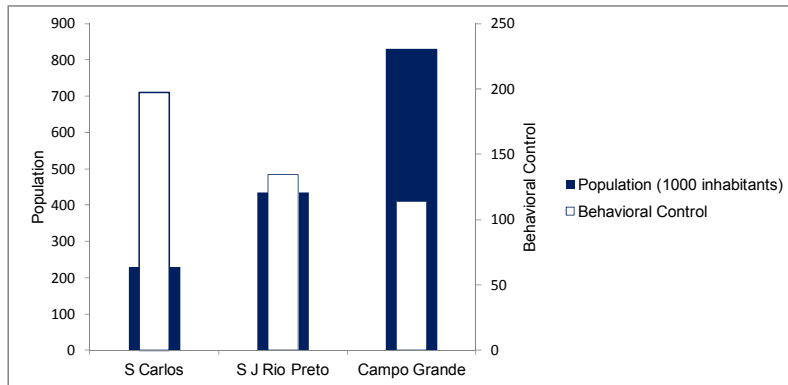

Fig. 3.Relationship between population and the overall behavioral control in the three cities

4.3. Comparison of the perceived barriers according to automobile users and non-users

The automobile is the most used mode for commuting (46.6% of journeys are made by car). In this section, a comparison is made between behavioral control beliefs and barriers for users and non-users of automobile (Figure 4).
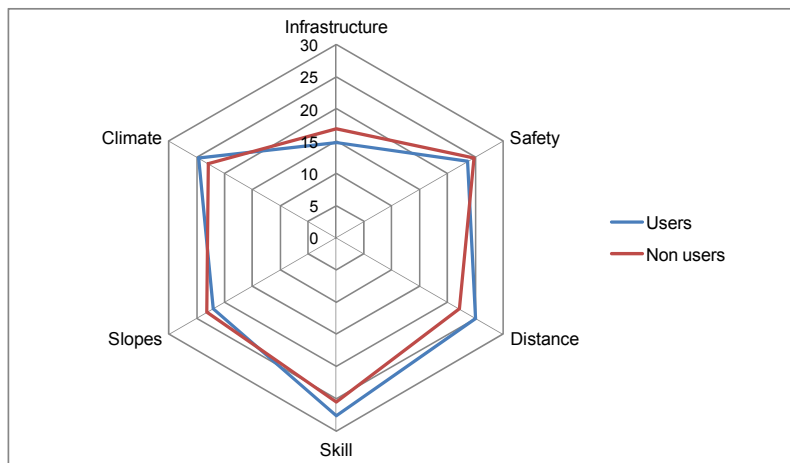

Figure 4– Behavioral control perception according to automobile users and non-users

As expected, automobile users have stronger and more negative belief control with respect to the use of bicycles in the distance, skills and climate variables than users of other modes of transport, whose belief is more neutral.

6. Conclusions

This article has assessed the perception of a group of individuals, in three Brazilian medium-sized cities, with respect to barriers that may hinder the use of bicycles as a mode of transport for commuting. The concept of perceived behavioral control, one of the constructs of the Theory of Planned Behavior was used for the assessment.

The barriers were evaluated by six statements related to the perception of perceived behavioral control. The results show that the strongest perceived barrier (smallest behavioral control) in all three cities is the lack of dedicated cycling infrastructure. This result emphasizes how important an adequate cycling network is for encouraging and increasing the use of bicycles for commuting.

For the other five barriers evaluated (safety, distance, skill, slopes and climate), there are differences among the cities. For instance, in São Carlos, slopes are the second strongest barrier, while in Campo Grande, security and climate are considered the second most significant barrier (weakest behavioral control).

The analysis of the size of the cities versus the perceived behavioral control revealed that the larger the city, the lower the level of behavioral control (stronger barriers).

In relation to the general perception of behavioral control, five groups were defined: very weak, weak, average, strong and very strong control. Nearly half of the respondents (46.8 %) have an average perceived behavioral control and the second largest group (35.3 %) is composed of those who claim to have a weak perception of control.

It is important to point out that this study has two limitations that require further analysis: (1) the sample consisted of students from only three Brazilian medium-sized cities which present conditions of topography and climate suitable for cycling and a low bicycle modal share. It is necessary to analyze the behavior of students from other cities with other characteristics and (2) the sample was relatively small compared to the number of students in the cities and, moreover, the 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.

Acknowledgment

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.. From Intentios to Actions: A Theory of Planned Behavior. In: KUHL, Julius; BECKMANN, Jürgen (Eds), *Action Control: from cognition to behavior.* New York: Springer, p.11-39, 1985.

Ajzen, I. (1991). The theory of planned behavior, *Organizational Behavior and Human Decision Processes* 50, p. 179-211.

Ajzen I.; FISHBEIN, Martin. The Prediction of Behavior From Attitudinal and Normative Variables. *Journal of Experimental Social Psychology*, n.6, p.466-487, 1970.

Anable, J. (2005) 'Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behavior 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*.

Dijkstra, A. Levelt, P.; Thomsen, J., Thorson, O., Van Severen, J. et. al. *Best practice to promote cycling and walking. Analysis and Development of New Insight into Substitution of short car trips by cycling and walking* – ADONIS. Copenhagen.

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 – CongresoPanamericano de Ingenieria de Tránsito, Transporte y Logística*, Santiago

Titze, S.; Stronegger, 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.