

# What explains the current and future choice of modes of transport by first-year undergraduate students?

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## RESUMO

### O que explica a escolha atual e futura de meios de transporte por alunos de primeiro ano de graduação?

Este estudo tem como objetivo compreender como os alunos do primeiro ano de graduação escolhem o meio de transporte para ir para a universidade, em Curitiba (Brasil), e analisar a escolha pretendida para o futuro. Um questionário baseado na Teoria da Motivação de Proteção foi aplicado em 372 estudantes ( $M = 19,43$  anos;  $DP = 1,87$ ). O custo financeiro foi o principal motivo da escolha dos modais. O ônibus foi o meio de transporte mais utilizado na atualidade (64.5%), mas a maioria dos estudantes não pretendia continuar a utilizá-lo daqui a 10 anos para se deslocar para o trabalho, pois 91,1% deles pretendiam utilizar o carro. A autoeficácia impactou na escolha do carro e do ônibus. Embora os participantes entendessem que o tráfego motorizado prejudica o meio ambiente, o comportamento ecológico não estava expressivamente relacionado à escolha de modos de transporte mais sustentáveis. Os resultados são discutidos em termos da necessidade 1) das universidades abordarem os transportes e o ambiente; 2) das ações governamentais para melhorar a qualidade do transporte público.

**Palavras-chave:** Escolha de transporte, sustentabilidade, custo financeiro

## ABSTRACT

This study aims to understand how first-year undergraduate students choose their modes of transport for traveling to university in Curitiba (Brazil) and to analyze their intended choice for the future. A questionnaire based on the Protection Motivation Theory was administered to 372 students ( $M = 19.43$  years;  $SD = 1.87$ ). Financial cost was the main reason for choosing modes. Bus was the most used mode of transport in the present (64.5%), but most students did not intend to continue using it in 10 years' time for traveling to work, as 91.1% of them intended to use the car. Self-efficacy impacted the choice of car and bus. Although they understood that motorized traffic impacts the environment, ecological behavior wasn't expressively linked to the choice of more sustainable modes. The results are discussed in terms of the need for 1) universities to address transport and the environment; 2) government actions to improve the quality of public transport.

**Keywords:** Transportation choice, sustainability, financial cost

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The present study aims to analyze the reasons behind the choice of modes of transport of first-year undergraduate Brazilian students in the short and medium terms: respectively in the present, for traveling to university, and their intention for the future (in 10 years' time), for traveling to work. For this purpose, the extent to which safety issues (protective behavior), the preservation of the environment and financial cost are related to their choice of modes of transport was examined. The focus on first-year undergraduate students as a target population was motivated by two elements: 1) young people are exposed to a great risk in traffic, and 2) they have an important role in preserving the environment in the short and long term.

The study was carried out in Curitiba, one of the largest state capitals in Brazil, located in the southern region, with an estimated population of 1,963,726 inhabitants (Brazilian Institute of Geography and Statistics, IBGE, 2023). It is considered the birthplace of Bus Rapid Transit (BRT) and has 208.5 km of cycle paths, covering 48.3% of the streets (Curitiba Institute of Urban Planning and Research, IPPUC, 2018). The [Information suppressed to avoid identifying the author(s)], the institution where the study was carried out, offers free transport to students who need to move between university campuses (a bus called "Intercampi"; Federal University of Paraná, 2023).

This paper is divided into five main sections; the first one (the introduction), contains four subsections. The first subsection presents the road risks; the second, reasons for choosing modes of transport, including the preservation of the environment and the financial cost of transportation; the third provides the theoretical framework (Protection Motivation Theory); and finally, the hypotheses of the present study are presented. The second section provides the method, and the third section focuses on the results. The fourth section discusses the results, including the presentation of limitations and possible applications. The last section is a brief exposition of the conclusions.

## ROAD RISKS

From a global perspective, road traffic crashes are the leading cause of death of young people up to 29 years of age (World Health Organization, 2018). In Brazil, in 2021, the age group with the highest number of traffic fatalities was between 20 and 24 years old (Brasil, 2023). In 2020, the bus was the safer mode of transport in Brazil, and most deaths occurred amongst motorcycle (36.7%) and car users (21.4%; Brasil, 2020). Campaigns and education should prioritize promoting the transition from high-risk modes of transport to safer alternatives (Litman, 2018; Chen & Jou, 2019).

Although in theory traffic and the environment are topics that should be addressed at all levels of education in Brazil in line with legislation (Brasil, 1997), this doesn't happen in

practice. For example, a study carried out in Curitiba showed that students never received guidance on safe cycling at school (Mossa et al., 2020). Thus, education should emphasize enhancing cyclists' road behavior by addressing traffic violations and errors, thereby improving overall safety (Useche et al., 2022). Regarding the use of bicycles, in addition to education, it is necessary to have the appropriate urban infrastructure: parents don't consider the streets safe for their children to go to school by bicycle (Mossa et al., 2020). Two examples of important measures are the construction of cycle lanes and parking areas (Yang et al., 2018). This is consistent with one of the key guidelines of Brazil's National Urban Mobility Policy (Lei nº 12.587, 2012), which emphasizes prioritizing non-motorized transportation over motorized modes and favoring public transit services over individual motorized transport.

## REASONS FOR CHOOSING MODES OF TRANSPORT

Among Brazilians who attend federal universities, most of them use public transport (46.1%) to travel to university, followed by cars or motorcycles (34.1%; National Association of Directors of Federal Higher Education Institutions, ANDIFES, 2019). Considering that habit serves as a direct antecedent of car use behavior (Feitosa, 2017), the period in which young people predominantly choose public transportation presents a crucial opportunity for intervention. Starting university involves a change in young people's habits and, at this time, they have to make their first choice of modes of transport. Earlier in their lives, their parents influenced them in this decision.

In addition to increasing safety, reducing car use can also improve air quality and make commuting cheaper for young people. In order to formulate effective policies to reduce transport-related carbon emissions, it is necessary to understand the factors that are involved in choosing modes of transport (Yang et al., 2018). Indeed, the transportation sector is one of the largest emitters of CO<sub>2</sub>, the most important greenhouse gas (Intergovernmental Panel on Climate Change, IPCC, 2022). Reversing this scenario would require a greater use of public or non-motorized transport modes (IPCC, 2022; International Transport Forum, ITF, 2024).

Efforts to engage people in pro-environmental collective action will be most successful when alternatives are clear and plausible (e.g., subway, bicycle), with very specific steps to achieve this goal (Wright et al., 2020). A study conducted in China showed that improvements in public transport can reduce carbon emissions by between 12.3 and 16.6% (Yang et al., 2018). Women tend to have more environmentally friendly behaviors than men, including the habit of using more public transport (Vicente-Molina et al., 2018).

The satisfaction of public transport users is affected by crowding (Soza-Parra et al., 2019). The longer the transport takes to arrive, the greater the crowding inside it. In addition to waiting time, commuting time is also an important variable; the choice of modes of transport is impacted by the commute duration (Vos et al., 2022).

Two other factors are important for choosing transport modes: comfort and security. For public transport users under the age of 35, the comfort experienced plays an important role in service satisfaction (Soza-Parra et al., 2019). In Brazil, Feitosa et al. (2014) showed that individuals prioritize their own interests over environmental concerns, opting to pay more to use private cars rather than public transportation. This preference may be attributed to the negative perception of public transit and the pleasure associated with car use.

Regarding public security, it has a significant impact on mobility, particularly for women (Ceccato & Loukaitou-Sideris, 2022). Many women feel anxious and worried while waiting for public transport, because they do not feel safe. In several countries, women use public transport more than men because they generally have lower incomes (Chowdhury & Wee, 2020). In Brazil, most women feel unsafe while traveling, with fear intensifying throughout the day. Their main concerns include harassment, sexual assault, and robbery, leading to demands for increased policing and better public lighting. Many have already experienced violence, with 71% facing incidents while walking and 56% while on buses. Public transport, especially buses and trains, is perceived as the least safe, whereas cars are considered the most secure option (Institute Patrícia Galvão, 2023).

Regarding the financial cost of transportation, the study by Maia et al. (2020), conducted among Brazilian university students, showed that public transport is the option most used by low-income youngsters, mainly due to the lack of alternatives. On the other hand, those who can afford higher costs mainly choose the car. Among Brazilian southerners attending federal universities, 60.9% have a per capita income of up to 1.5 of the minimum wage (ANDIFES, 2019).

## **PROTECTION MOTIVATION THEORY (PMT)**

This study is grounded in the Protection Motivation Theory (PMT; Rogers, 1975, 1983), a health promotion model that can be applied to both injury prevention and environmental concerns. By providing a framework for understanding individuals' motivation to adopt more protective or less risky behaviors, the PMT can be used to investigate how people select their mode of transportation in response to perceived traffic hazards.

According to the PMT, when people are faced with a threat, they experience the cognitive process of threat and

coping appraisals. The first is a personal assessment of how serious the threat is (severity) and the likelihood of a threat to occur (vulnerability), e.g., "I could be a traffic victim using the mode of transport I use". In addition, it includes maladaptive rewards, that is, the perceived benefits of continuing to perform risky practices, e.g., "The mode of transport I use brings me some benefits".

Regarding coping appraisal, this assesses how the person responds to the situation, that is, the effectiveness of the response that will remove the threat. The main components are self-efficacy (the degree to which the person believes they are capable of performing the behavior), e.g., "I am free to choose the mode of transport I use"; response efficacy (perceived effectiveness of the behavior), e.g., "My choice of mode of transport can contribute to safer traffic"; and response cost (perceived difficulties of performing the behavior), e.g., "Great effort is required to use safe modes of transport". Fear and hope, affective responses, can contribute to performing a protective behavior, motivating people to act against threats (Halevy, 2017). Thus, the theory can be used when there is a threat, and an effective recommended response can be performed by people.

## **HYPOTHESES**

Four hypotheses were tested about the current and future choice of modes of transport.

H1: There is a relationship between urban structure/quality of services and the choice of mode of transport.

H2: The financial cost of transportation is an important variable for explaining how students travel to university.

H3: Ecological behavior can predict the choice of public transport and non-polluting transport in the future (in 10 years): students with higher rates of ecological behavior have a greater intention to use sustainable modes of transport in the future.

H4: The Protection Motivation Theory components and affective responses can explain the current choice of car and bus.

## **METHOD**

### **PROCEDURE**

Data were collected through a printed questionnaire, administered in the classrooms of the Federal University of Paraná. The approximate time taken to complete the questionnaire was 20 minutes. This study was previously approved by the Human and Social Sciences Ethics Committee of the Federal University of Paraná (CAAE

n.59273722.5.0000.0214) and people did not need to identify themselves.

### QUESTIONNAIRE MEASURES

The administered questionnaire was drawn up by the authors, and contained questions based on the literature and on the PMT. It also contained a validated scale for the Brazilian population, the "Ecological Behavior Scale" ("Escala de Comportamento Ecológico"; Pato & Tamayo, 2006). All Likert scales in this study were 4-point scales, except for the Ecological Behavior Scale, which was 6-point. A 4-point scale was chosen to encourage participants to commit to a response, eliminating the possibility of selecting a neutral middle option. This approach ensures a more decisive and engaged response. The Ecological Behavior Scale was maintained with six points, as it has been previously validated in this format. The questionnaire was composed of 126 questions, divided into five sections. First, general information, including distance between home and university, class schedule, work, etc. Second, questions about transport, e.g., modes of transport currently used for traveling to university, intentions for use in the future for traveling to work, availability of public transport and bicycle lanes, etc. Then, sociodemographic data, such as gender and age.

The fourth section was about questions related to the PMT and affective components: the threat-appraisal process was measured through the combination of perceived severity and perceived vulnerability, and maladaptive rewards (Rippetoe & Rogers, 1987). The coping-appraisal process was measured through self-efficacy (strongly disagree-strongly agree). Affective responses were measured through hope and fear. Participants stated in response how they felt when they thought about traffic risks (not at all-extremely); e.g., "I feel extremely scared when I think about the mode of transport I use to travel to university". Each component was accessed through the items displayed in Table 1 with the correspondent Cronbach's Alpha, which varied between 0.68 and 0.90.

Lastly, the students responded to the "Ecological Behavior Scale" (Pato & Tamayo, 2006). This is a self-reported scale that measures the frequency (never-always) of behaviors. This scale is composed of 29 items, however, in the present study, one item was excluded after the reliability analysis. Thus, the factors were divided as follows: Activism-Consumption (9 items;  $\alpha = 0.8$ ; refers to active participation involving other people or a refusal to use products considered harmful to the environment); Water and Energy Saving (12 items;  $\alpha = 0.7$ ; refers to the rational use of natural resources, especially water and energy); Urban Cleaning (4 items;  $\alpha = 0.6$ ; refers to the behavior of not throwing garbage in inappropriate places, keeping public

spaces cleaner); and Recycling (3 items;  $\alpha = 0.7$ ; refers to separating domestic garbage according to its type). The Cronbach's alpha of the general scale was 0.82.

**Table 1. PMT components and affective responses: items and Cronbach's Alphas**

Component	Items	$\alpha$
Perceived vulnerability/ severity	"Using the mode of transport I use leaves me vulnerable in traffic" "I could be a traffic victim using the mode of transport I use" "I feel threatened when traveling with the mode of transport I use."	0.68
Maladaptive rewards	"It is good for me to use the mode of transport I use" "The mode of transport I use brings me some benefits"	0.80
Self-efficacy	"The mode of transport I use was chosen by me" "I am free to choose the mode of transport I use" "I could use another mode of transport if I wanted to"	0.81
Hope	Hopeful, optimistic, encouraged	0.90
Fear	Afraid, apprehensive, scared	0.85

### PARTICIPANTS

First-year undergraduate students from the [Information suppressed to avoid identifying the author(s)] participated in the study (N = 372; this sample was expected, with a 5% margin of error and a 95% confidence level, considering a population of 3,698 people, the total number of students approved to start the first university year in Curitiba). As inclusion criteria, participants were required to be between 18 and 25 years old and in their first year of an undergraduate program at the university's campuses in Curitiba. Consequently, individuals outside this age range or those attending only a single course as part of the first-year curriculum, but who were actually enrolled in higher years, were excluded. The sample characteristics are presented in Table 2. The average age of the participants was 19.43 years ( $SD = 1.87$ ) and 54.6% considered themselves as female (gender self-declaration). The average distance between home and the campus where the participant studied was 10.88 kilometers ( $SD = 15.63$ ). Among participants who worked (28.4%), the average number of hours worked was 30.16 per week ( $SD = 12.90$ ).

**Table 2. Sample characteristics**

Characteristics	N	%
Gender		
Male	156	41.9
Female	203	54.6
Other	13	3.5
Have driver's license (car or motorcycle)		
Yes	84	35.5
No	167	66.5
Home-university distance		
0 – 5 km	131	36.0
6 – 10 km	111	30.5
More than 10 km	122	33.5
Living with parents		
Yes	237	69.3
No	105	30.7
Weekly amount spent on commuting between home-university (Reais)		
R\$ 0.00	85	23.5
R\$ 1.00 - R\$ 55.00	73	20.2
R\$ 56.00 - R\$ 100.00	143	39.6
More than R\$ 100.00	60	16.7
Class schedule		
Morning	114	30.6
Morning and afternoon	128	34.4
Night	118	31.7
Other	12	3.3
Total	372 <sup>1</sup>	100

Note. <sup>1</sup> Including missing cases.

## DATA ANALYSIS

The data in this study are quantitative and were analyzed using the IBM Statistical Package for the Social Sciences Software 20. Descriptive statistics (means, standard deviations and frequencies), one-way ANOVA, correlation, reliability, and inferential analysis were conducted.

## RESULTS

The results are reported here in four parts: 1) descriptive analysis regarding the participants' current transport patterns and their intention for the future, 2) reasons for

choosing modes of transport, 3) Concern about the environment; and 4) The impact of the PMT components on the choice of modes of transport.

### DESCRIPTIVE ANALYSIS REGARDING THE FREQUENCY OF PARTICIPANTS' CURRENT TRANSPORT AND THEIR INTENTION FOR THE FUTURE

Table 3 presents how often the participants used each mode of transport to travel to university in the present and intended use for the future. The bus stands out as the most used mode of transport among students (64.5%). Regarding the low rate of bicycle use (4.4%), it is interesting to note that 56.2% of participants' state that there was no cycle path or lane between their home and the university.

Commuting for daily activities plays an important role in people's lives: 91.6% of participants stated that when they imagined their ideal job, the way of commuting to the workplace was considered as part of it. For the future, they preferred the car over other transport possibilities. The bus, which was currently the most used mode of transport (64.5%), was one of the modes of transport that students were least willing to use in the future (36.6%).

**Table 3. Percentage of modes of transport used frequently or always for commuting to university (present) and intention for commuting to work (in 10 years' time)**

Modes of transport	% present	% future
Bus	64.5	36.6
Walk	24.4	-
Car (ride)	21.3	-
University bus ("Intercampi")	18.4	-
App car/ Taxi	13.3	-
Car (the participant drives)	11.7	91.1
Bicycle	4.4	42.8
Motorcycle	3.1	37.9
Van	3.0	-
E-bike/ e-scooter	0.3	-
Subway (if available)	-	49.8
Driverless cars, drones, or other (not yet available)	-	58.6

Note. People can use more than one mode of transport. 4-point scale: Never, Sometimes, Frequently and Always. "-" this was not asked.

**REASONS FOR CHOOSING MODES OF TRANSPORT**

To test hypothesis 1, an analysis of variance was performed to identify the differences between two groups: a) students who reported that there were cycle paths between their home and the university and b) students who reported that there was no cycle path on this route; regarding the frequency of current bicycle use. In addition, an ANOVA was performed on two other groups: 1) students who intended to use the bus in the future and 2) students who did not intend to use the bus in the future, regarding the time they take on the bus to go to university. Table 4 shows the statistically significant results of differences between groups, but all with low effect size.

**Table 4. Differences between groups according to infrastructure or quality of service provided**

Continuous variable	Bicycle frequency use (1-4)	Minutes home-university by bus
Group variable 1	There is a cycle path	Intend to use bus
Group variable 2	There is no cycle path	Do not intend to use the bus
Df1/df2	1/250	1/390
F	3.76*	7.30
Effect size est. $\omega^2$	0.01	0.02
Welch's cor-rec-tion <sup>1</sup>	No	Yes
p	0.05	<0.01

Note. <sup>1</sup>Bootstrapping was performed (1000 re-samplings; 95% CI BCa).

Hypotheses 1 was corroborated: students who had access to a cycle path between home and the university used the bicycle more (mean = 1.29, SD = 0.80) than students who did not have access to one (mean = 1.13, SD = 0.51). However, the frequency of bicycle use was low in both cases. This indicates that other interventions are needed in addition to the construction of cycle paths to increase their use as a mode of transport.

In general, the commute time between home and university was, on average, 21.09 minutes (SD = 13.79) by car and 47.01 (SD = 30.54) by bus. People who intended to use the bus in the future took an average of 41.09 (SD = 30.17) minutes to travel to university, while people who did not intend to use the bus in the future took an average of 50.65 (SD = 30.41) minutes for this trip. Thus, hypothesis 1 was completely confirmed: participants who intended to use buses in the future had a lower average commuting time by bus.

A set of seven criteria was used to assess the reasons for choosing the modes of transport used by the participants for traveling to university. As shown in Table 5, the three most important reasons for our participants were financial cost, time-saving, and comfort. Environmental preservation was the least considered selection criteria.

**Table 5. Criteria for choosing the modes of transport for traveling to university (present)**

Possible reasons	M*	SD
Financial cost	3.51	0.75
Time-saving	3.22	0.90
Comfort	2.86	1.02
Risk of robbery or theft	2.78	1.00
Risk of crash	2.64	0.96
Risk of sexual harassment	2.56	1.10
Environmental preservation	2.42	0.91

Note. \* Strongly disagree (1) – strongly agree (4)

A one-way ANOVA was performed, using bootstrapping procedures (1000 re-samplings; 95% CI BCa) and Welch's correction, to check whether there was a difference between the groups of students who lived or didn't live with their parents in relation to the consideration of the financial cost in choosing the mode. The ANOVA results showed that there were significant differences between the groups [Welch's F<sub>(1,294.60)</sub> = 10.97, p ≤ 0.001]: students who lived with their parents considered the financial cost less (M = 3.46; SD = 0.77) as a criterion for choosing modes of transport than students who lived alone, with friends or with siblings (M = 3.71; SD = 0.59); the effect size was low (est. $\omega^2$  = 0.03). Thus, hypothesis 2 was supported: among the options offered, the financial cost had the highest average as a criterion for choosing modes of transport, with a significant difference between students who lived and did not live with their parents. A one-way ANOVA also showed significant gender differences in how much students considered the risk of sexual harassment [F<sub>(1, 353)</sub> = 44.59, p < 0.001; est. $\omega^2$  = 0.11], with women considering it more (mean = 2.88; SD = 1.10) than men (mean = 2.14; SD = 1.01).

**CONCERN ABOUT THE ENVIRONMENT**

Four questions were asked to understand more about students' beliefs about transportation and the environment. Students understood the relationship between modes of transport and air pollution, as well as their responsibility in this, the results are in Table 6.

**Table 6. Students' beliefs about transportation and the environment**

Questions	M*	SD
The mode of transport I choose impacts the environment	3.02	1.01
Using a bus is better for the environment than using a car	3.37	0.83
Everyone can collaborate for their journeys to emit less CO <sub>2</sub>	3.37	0.83
Preservation of the environment must be considered by the government and not by the people who need to commute for daily activities	2.14	1.02

Note. \* Strongly disagree (1) – strongly agree (4)

After the question about beliefs, students responded to the Ecological Behavior Scale. They had an average total score of 3.80 (SD = 0.60), the closer to 6, the more ecologically correct the behavior was. The average of each factor was: 2.59 (SD = 0.86) for Activism-Consumption, 4.07 (SD = 0.74) for Water and Energy Saving, 5.22 (SD = 0.72) for Urban Cleaning and 4.50 (SD = 1.30) for Recycling. There was a statistically significant difference between men and women regarding the total score: [F<sub>(1, 357)</sub> = 13.51, p ≤ 0.01; est.ω<sup>2</sup> = 0.03]: women had a higher score (M = 3.89; SD = 0.61) than men (M = 3.66; SD = 0.55). To test the relationship between ecological behavior and the intention to choose the bus or non-polluting transport in the future, according to hypothesis 3, linear regression analyzes were carried out. Although there was a significant result for the Activism-Consumption and Recycling factors in both cases, the adjusted R<sup>2</sup>s were low (0.068 and 0.046, respectively).

#### THE IMPACT OF THE PMT AND AFFECTIVE RESPONSE COMPONENTS ON THE CHOICE OF MODES OF TRANSPORT

A linear regression analysis (forward method) was performed to investigate the contribution of variables to estimate current bus use. The variables gender, age, PMT components (threat vulnerability/severity, maladaptive rewards, self-efficacy) and affective responses (hope and fear) were included. The results showed a significant influence of hope, self-efficacy, maladaptive rewards, and threat appraisal on bus use (F<sub>(4, 349)</sub> = 42.61, p < 0.001; adjusted R<sup>2</sup> = 0.32), on which hope had the greatest impact. The greater the frequency of bus use, the lower was hope, self-efficacy, maladaptive rewards, and threat vulnerability/severity.

The same analysis was performed to check the contribution of these variables to estimate current car use (driving). There was a significant influence of age, self-efficacy, and gender on car use (F<sub>(3, 342)</sub> = 25.39, p < 0.001; adjusted R<sup>2</sup> = 0.18). The greater the frequency of car use, they are more likely to be male, with higher self-efficacy and age.

Thus, hypothesis 4 was partially confirmed: some PMT components and affective responses had a significant impact on the frequency of bus (hope, maladaptive rewards, self-efficacy and threat vulnerability/severity) and car (self-efficacy) use, but others had not.

#### DISCUSSION

The present study aimed to understand: 1) the choice of modes of transport made by students for commuting to university in the present and 2) the intended choice of modes of transport in the future (10 years' time), for traveling to work. To address the initial research question that underpins this study ("What explains the current and future choice of modes of transport by first-year undergraduate students?"), four hypotheses were formulated and tested. The results confirmed some of the hypotheses proposed.

Hypothesis 1 was supported: in line with the literature (Mossa et al., 2020; Yang et al., 2018), our study showed that students who have a cycle lane on their way to university use it more frequently. This finding highlights the necessity for policymakers to invest in infrastructure improvements, such as expanding cycling networks and improving pavement quality, to facilitate safer and more accessible mobility for those using active transportation. In addition, students who spent less time on their bus commuting were more interested in using the bus in the future for traveling to work, agreeing with Vos et al. (2022). The average commute time for students who used the bus was more than twice the average time when using a car to travel to their university. Considering that the results indicated "time-saving" and "comfort" as the two most important criteria for young people's transportation choices after "financial cost," public transport must necessarily improve in terms of comfort (including reduced crowding, adequate temperature, and cleanliness), punctuality, predictability, and availability.

The risk of theft and sexual harassment were not the most important criteria for choosing a mode of transport. In any case, it is important that public transport is safe in terms of security in order to be attractive to people, especially women (Chowdhury & Wee, 2020), who had a significantly higher mean for "risk of sexual harassment", in line with Ceccato and Loukaitou-Sideris (2022).

"Financial cost" was the most important criterion for the students' choice of modes of transport for traveling to university, confirming hypothesis 2. This result was expected, since 60.9% of the students who attend federal universities in the south of the country have a per capita income of up to 1.5 of the minimum wage (ANDIFES, 2019). If students do not live with their parents, they must pay other expenses such as electricity, the internet, and housing bills.

For this reason, our study showed that the financial cost of transportation was an even more important variable for students who did not live with their parents. The high relevance of the financial cost explains why the bus is the most used mode of transportation by students, although many students did not want to choose it, in agreement with Maia (2020).

This study showed that 91.1% of participants stated that in 10 years they would like to use their car to go to work, which could be harmful both from an environmental (ITF, 2024) and a road safety (Brasil, 2020) point of view. This data contains a warning for the future: if public transport or infrastructure for micromobility are not improved, students will tend to choose the car to go to work. It is also important to change the image that Brazilians have of public transport, associating it with a lack of financial resources. In addition, our study shows that if Brazil wants to have more sustainable and safer transport in the future, actions are needed in the present, such as greater safety for micromobility travel and agility in public transport.

Regarding the environment, the participants had a mean score of 3.80 on the Ecological Behavior Scale, which represents a slightly positive behavior on the 6-point scale. Consistent with the literature (Vicente-Molina et al., 2018), women had a statistically significant higher score than men. However, hypothesis 3 was only partially confirmed: ecological behavior in other areas, such as saving water and electricity or keeping the city clean, could not predict the choice of public transport and non-polluting transport (e.g., bicycle) in the future. In addition, the prediction of Activism-Consumption and Recycling was very low. Although the analysis of beliefs showed that students understood that some modes of transport can have a detrimental impact on the environment.

Implementing campaigns represents a promising approach to addressing these findings by enhancing awareness of the environmental impact and safety risks associated with different modes of transport, thereby enabling individuals to make more informed decisions. However, the campaigns should not only focus on educating young people about this impact, but rather on encouraging them to take this factor into account when making their choices. People who want to take care of the environment need to consider the impact that their choice of mode of transport has on air quality (IPCC, 2022). Therefore, the use of public transport and active transport should be encouraged (Yang et al., 2018), and the alternatives must be clear, affordable, and plausible (Wright et al., 2020).

These campaigns, aimed at both awareness and behavioral change, can be implemented not only at the target university of this study but also across all universities in the city. Expanding these initiatives to multiple institutions

can help foster a broader culture of sustainable and safe mobility among students. Universities must prepare students for citizenship, as well as for their profession. Reflecting on this social role of the university, in addition to the campaigns, our study highlights the importance of treating environmental education as a transversal issue, so that students feel involved in this and understand their role, in an attractive way. For this to happen, it is necessary, once the appropriate infrastructure is in place, to prepare the professors: they must have the necessary knowledge and understanding of the subject to also have the motivation to approach it.

Interestingly, the component that explained bus usage the most was hope, the greater the frequency of bus use, the lower was hope. This means that students don't feel optimistic, encouraged, and hopeful when they think about the mode of transportation they use to go to university. However, the bus is the mode of transport in which the fewest people die due to crashes in Brazil (Brasil, 2020). Students feeling safe on the bus is important, given that with an increase in the use of public transport, there would be an increase in people's safety in traffic (Chen & Jou, 2019).

Regarding the use of the car, the PMT component that explained it the most was self-efficacy. According to Rogers (1983), self-efficacy is related to the belief of being able to perform the target behavior, in the case of our study, the behavior is the choice of transportation modes. Thus, when people feel free to choose their mode of transportation, they tend to choose a car. Furthermore, the greater the frequency of bus use, the lower the self-efficacy. This result is also consistent with Feitosa et al. (2014), who highlight that personal interests take priority in Brazil when it comes to the choice of transportation mode. Since not all PMT components were significant in the choice of a car, hypothesis 4 was partially supported by this study. A low  $R^2$  value found for the car use regression (0.18) demonstrates that the proposed model does not account for a large portion of the variation in the dependent variable. This is one of the limitations of the study, and new models should be addressed in future research, as there may be other important variables not considered in the present study.

The present study has two main limitations: 1) all students were from the same city and university (convenience sampling), which could generate a pattern in the responses; and 2) it was not possible to verify the socioeconomic level of the students due to the lack of an appropriate instrument. No student pays to attend their undergraduate course, as the university is public, but 50% of the places are reserved for students with a low income. Therefore, it is recommended that future research employ different sampling procedures (probability sampling) and include a broader range of Brazilian cities. Additionally, the

socioeconomic status of the target population should be considered, as it may be an important variable in the choice of transportation mode.

Given the well-established knowledge about the dangers associated with car use, strategies must be developed to promote the adoption of public transport and micromobility. As final considerations of this study, it is important to highlight that such strategies should focus on two key aspects: 1) infrastructure improvement, including the enhancement of bike paths and public transport, and 2) education, incorporating factors such as hope, self-efficacy, maladaptive rewards, and threat appraisal into the design of interventions, as well as encouraging students to consider the environment when making their transportation choices.

### CONTRIBUTION OF EACH AUTHOR

Certificamos que todos os autores participaram suficientemente do trabalho para tornar pública sua responsabilidade pelo conteúdo. A contribuição de cada autor pode ser atribuída como se segue:

E.L.B. contribuiu para conceitualização, metodologia, análise formal dos dados e redação inicial do artigo (rascunho). P.D., S.B. e A.S. foram responsáveis pela conceitualização, metodologia e redação final (revisão e edição).

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### DECLARATION OF CONFLICTS OF INTEREST

The authors declare that they do not have conflicts of interest regarding the presente manuscript.

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