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Travel perception and mode choice: a descriptive and exploratory factor analysis of a pilot survey addressed to students of UFRRJ (Universidade Federal Rural do Rio de Janeiro)

Percepção e escolha do modo de transporte: análise fatorial descritiva e exploratória de um questionário piloto aplicado aos estudantes da UFRRJ (Universidade Federal Rural do Rio de Janeiro)

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ABSTRACT
Universities generate a significant volume of daily commuting, in addition to being a favorable environment for development of new habits and behavior, as result of the influence among those who attend them. This study addressed a survey, based on Theory of Planned Behavior and Theory of Human Motivation, to UFRRJ students in order to identify the factors taken into account in travel decisions and to collect their perceptions about the transportation system in metropolitan region of Rio de Janeiro. The results were achieved by exploratory factor analysis and interviews. The findings corroborate the already consolidated application of Theory of Planned Behavior on travel research and confirmed the existence of a hierarchy of transport needs suggested by the Theory of Human Motivation, which denotes its potential as a tool for transport policies design. The study also revealed the importance given by students to travel time over other needs, the strong influence of the safety attributes on decisions and a high awareness of the social and inclusive role of transport.

RESUMO
As universidades geram um volume significativo de deslocamentos diários, além de ser um ambiente favorável ao desenvolvimento de novos hábitos e comportamentos, em decorrência da influência exercida entre seus frequentadores. Este estudo aplicou um inquérito, baseado nas Teorias do Comportamento Planeado e da Motivação Humana, aos estudantes da UFRRJ, com o objetivo de identificar fatores relevantes para decisões em transporte e coletar suas percepções sobre o sistema de transporte na região metropolitana do Rio de Janeiro. Os resultados foram alcançados por análise fatorial exploratória e entrevistas. Os resultados corroboram a já consolidada aplicação da Teoria do Comportamento Planeado nas pesquisas sobre transporte e confirma a existência de uma hierarquia de necessidades de transporte sugerida pela Teoria da Motivação Humana, o que destaca seu potencial como ferramenta de apoio à decisão no desenvolvimento de políticas de transporte. O estudo evidenciou ainda a relevância do tempo de viagem sobre outras necessidades, a forte influência dos atributos de segurança nas decisões de mobilidade e uma elevada consciência do papel social e inclusivo do transporte.

1. INTRODUCTION

Many theories concerning human behavior, choice processes and decision-making on the consumption of goods and services emphasize the influence of personal experiences and lifestyle over the way people react to the information and incentives they receive and how these factors greatly impact their decisions and level of satisfaction (Ajzen, 1991). This applies also to urban mobility, as commuting patterns do not depend exclusively on the level of transport service, but also derives from socio-psychological factors, such as beliefs, attitudes, habits and preferences (Targa and Clifton, 2004), related to a set of attributes, such as departure and arrival times, travel time, costs, among others (Bamberg et al., 2011), being also influenced by the socio-economic, demographic characteristics, and human needs (Allen et al., 2019; Perone et al., 2005; van Acker et al., 2019; Zhang et al., 2019).

As universities are hubs with a high number of daily commuting, the commuting behavior of students and university workers is relevant at understanding travel patterns in order to design strategies for sustainable mobility developing. Based on this justification, the present study, which is a preliminary step of a broader research, aims at collecting data defining the UFRRJ students' commuting profile and their perceptions about urban mobility. In addition, its intention was to validate the data collection instrument, "discovering how data collection protocols and research instruments work under realistic conditions" (Fowler Jr, 2014, p. 116), and minimizing the risk of a future and widely survey not providing the expected data or generating incorrect data (Brace, 2008). In order to confirm whether the survey generated the expected results, and identify any discrepancies between what was declared in the survey and the real opinion of the respondents (Fowler and Fowler Jr, 1995), a semi-structured interview was conducted with 10 subjects of the sample.

This research collects attitudes based on the Theory of Planned Behavior (TPB), developed by Ajzen (1991), and Theory of Human Motivation (also known as Theory of Needs or Maslow's Theory), developed by Maslow (1943). TPB is widely applied on explaining and predicting behavior studies (Bamberg and Schmidt, 2003; Kwon and Silva, 2020; Nayum and Nordfjærn, 2021). It considers that human behavior is essentially determined by three main aspects: attitude, social influence and perceived behavioral control (Ajzen, 1991). It means that, people take into account some available information and beliefs as well the consequences of their acts before perform a behavior. Hence, the strongly of each aspect depends on the context in which the decision to perform a behavior is made - the sum of attitude toward a behavior, the social influence on it and the perception of control produce a behavioral intention (Fishbein and Ajzen, 2009). On the opposite, Theory of Human Motivation is more applied to marketing and human resources than to travel behavior research (Cui et al., 2021; Ghatak and Singh, 2019; Gilal et al., 2021; Zhang et al., 2019). According to Maslow's Theory, the individual is an integrated whole and his needs, whether physiological or psychological, are allocated in a hierarchical pyramid, in which the physiological needs, such as hunger and sleepiness, are priority (bottom of pyramid) over psychological ones, such as self-esteem and self-realization (Maslow, 1943). In urban mobility, Human Motivation Theory can be used to classify citizens' needs according to their degree of priority, contributing to the development of public policies that prioritize the most urgent needs.

The present study uses Exploratory Factor Analysis to evaluate perceptions and attitudes of students concerning commuting and transportation system. Factor analysis is widely used to evaluate multi-item instruments in many research fields, such as psychology, education,

sociology, management, political science, public health (Brown, 2015), and in travel behavior studies to identify and explain travel patterns and supporting policies design to encourage the active modes engaging, among others objectives (Zorrilla et al, 2019; Hasan et al., 2019; Ledesma et al., 2021; Shafi et al., 2020).

2. THEORETICAL BACKGROUND

Studying the correlation between daily mobility decisions and people's psychological traits is useful for develop public policies to improve citizens' experience with transport, in addition to provide relevant information for health promotion, since trips are full of positive and negative emotions, such as happiness and tiredness, related to their duration, purpose and companionship (Zhu and Fan, 2018). Thus, mobility research based on attitudes, perceptions, habits, sociodemographic and economic features is widely found in recent literature.

In Swedish, a study mapped the role of driving habits, car attitudes, descriptive norms and motives on transportation mode selecting and concluded that the weight of socio-demographic and psychological variables depends on the trip purpose. Although driving habit had been observed as a common predictor among all trip purposes, it is notably stronger on leisure and shopping trips, while commuting and child-related trips had been mainly predicted by variables such as city size, environment issues, type of housing and income, and gender (Ramos et al., 2020). Likewise, a survey about a set of opposite features concerning transportation modes (noisy-quiet, masculine-feminine, modern-traditional, weak-powerful, basic-complex, humble-proud, young-mature), regarding to car, carpool, public transport (PT), bike and walking was addressed to Valencia (Spain) residents and concluded that adjectives such as powerful and modern were associated to car and carpool, while characteristics such as simple and humble were related to PT and non-motorized travel (Ruiz et al., 2018).

Aiming to identify an association between socioeconomic characteristics and transportation mode choice, a study applied to Seoul citizens (South Korea) concluded that the choice of mode is significantly influenced by factors such as gender, length of residence, density of bus stops and perceived parking conditions, travel time and negative perceptions of health conditions, especially among middle-income citizens (Ko et al., 2019). Also, understanding the different perception of young people, adults and elderly about PT quality, based on operational characteristics, comfort and user exposure to externalities, was the objective of a research addressed to residents of Porto Alegre (Brazil). The study concluded that operational characteristics (such as speed, departure and arrival delay, and congestion) is the most relevant factor on quality perception, particularly among young people. In turn, comfort and user exposure to externalities has a less and indirect influence on user’s satisfaction, being the older adults the most impacted by the exposure to externalities (Tavares et al., 2021).

Regarding to university community, research applied to Suranaree University of Technology (Thailand) aimed to design the travel pattern of undergraduate students, based on descriptive variables such as trip generation, mode split, distance traveled, and time spent on traveling (Limanond et al., 2011). An investigation at the Autonomous University of Barcelona (Spain) collected the motivations, opportunities and barriers to shift from motorized to non-motorized modes by the students and workers (Miralles-Guasch and Domene, 2010). Later, at the same university, another study aimed to rank the influence of spatial location, socioeconomics and social behavior on students’ travel-demand by car (Soria-Lara et al., 2017).

The evaluation of employees, professors and students' satisfaction related to transportation modes, based on personal, social, and attitudinal factors, was also subject of research at McGill University, in Canada (St-Louis et al., 2014). Likewise, a survey applied to a university community in Cachoeira do Sul, a small town in southern Brazil, evaluated the commuting habits of its students and workers and identified strong competition between private car and walking, with higher incidence of car use among workers and walking among students. The research also found a low adherence to public transport which suggests that policies to encourage the use of this mode should be adopted. (Oestreich et al., 2020). A study conducted at Faculty of Engineering of Oporto University (Portugal) identified and classified the main factors and variables influencing the student's mode choice and its eventual changing or adaptation during a financial crisis (Cadima et al., 2020).

TPB was used to predict the intention of citizens to use a new metro system in Qatar and found that, regardless of the purpose of the trip (work or leisure), encouraging a change in the attitude of commuter towards the metro is the most important way to increase the intention to use this upcoming transportation service, and perceived behavior control was found to be more relevant in commuting trips and subjective norms in leisure trips (Shaaban and Maher, 2020). Specifically on travel behavior of university students and workers, many studies were conducted from TPB perspective to understand their perception and commuting patterns, such as a study to collect car travelling intentions and behavior of students at Queensland University in Australia (Kerr et al., 2010) and a research about travel behavior of native and foreign students of Monash University, in Australia, aiming to investigate the role of nationality on travel decisions and mode choice (Shafi et al., 2020).

Theory of Human Motivation is rarely used on travel behavior research. Although some studies have shown its usefulness for research on mobility, especially on level of service and user satisfaction studies (Winters et al., 2001), the systematic literature review for this research, in which uniform criteria were adopted to identify, select and evaluate previous studies (Tranfield et al., 2003), found only two studies in 2010 – 2020 years (cited bellow) related to Theory of Human Motivation and PT or smart city evaluation. However, this literature review did not find any research on it related to travel behavior of university students or workers.

A classification of PT attributes in a hierarchy of needs was designed from the results of a survey conducted with users of bus rapid transit (BRT) in four Latin American cities. Reliability, accessibility, and speed (classified as essential for the service production); followed by perception of security against accidents and assaults, disruption of the service (security and safety); and aspects related to extra comfort and convenience such as number of seats available, wireless connection, and air conditioning (hedonic factors) were arranged in a pyramid of importance to users' satisfaction, named by the authors as "hierarchy of transit needs" (Allen et al., 2019). More broadly, a smart city evaluation model based on Theory of Human Motiation was developed in China, in which a set of indicators was matched in a hierarchy of residents' needs to classify 22 cities in a smart city ranking according to the weight given to each indicator. The study considered PT as a social need, beside mobile phone popularity rate, broad band access, urban network speed, an urban service development, preceded by safety and physiological needs and followed by esteem and self-actualization demand respectively (Zhang et al., 2019).

The literature shows that several studies use one or another theory of social psychology, in isolation, to explain the phenomenon of travel behavior, however there is a lack of comparative studies, which aim to identify the optimal theory to be applied depending on the observed context or to demonstrate the complementarity between two or more theories in explaining personal choices in urban mobility, which is the objective of the broader research, in which this preliminary study is inserted.

3. THE CASE STUDY

Universidade Federal Rural do Rio de Janeiro is a centenary Brazilian higher education institution with more than 16,000 students, enrolled over three campuses: Seropédica, Nova Iguaçu and Três Rios, located in Rio de Janeiro District (UFRRJ, 2019a). Regarding the availability of PT, the campuses are only served by bus (PMCRJ, 2017). Although Nova Iguaçu is a city served by rail, the distance between UFRRJ campus and its train station is around 3.6 km. Consequently, in the last mile of commuting, the access to all UFRRJ's campuses is only possible by bus or car.

The invitation to participate in a web-based survey was disseminated via the main online platforms used by UFRRJ to keep in touch with its students, and the call for participation encouraged the dissemination of the survey among peers. The questionnaire consisted of the following 6 sections: (i) interviewee's profile (sociodemographic data and university membership information); (ii) characteristics of daily commuting (distance, travel time, modes' frequency of use, and commuting expenses/monthly income); (iii) relevant factors for mode choice; (iv) perceptions about the available transportation system; (v) availability to share the commuting activities in the previous week and participate in an interview; and (vi) survey evaluation. The sections from (iii) to (v) were evaluated through a 5-point Likert Scale. The survey was conducted in December 2019, and it received 126 responses.

Following the application of the survey, invitation for the interview was sent to all respondents who declared interesting to participate (n = 31). Among those who were invited, 11 agreed to be interviewed, but 1 declined the invitation, and 20 did not respond to the invitation. The semi-structured interview was conducted by videoconference between March and July 2020 and consisted of 4 sections: (i) presentation of the objective of the interview and request for authorization to record it; (ii) description of commuting in the last time he/she went to university under normal conditions, before the Covid-19 pandemic (activities performed during the day, modes of transport used and motivation, whether it was a normal or atypical day); (iii) perceptions about the transportation system (quality, cost, comfort, safety, reliability and future expectation; and (iv) evaluation of the survey answered in the previous step.

4. RESULTS AND DISCUSSIONS

4.1. Sample descriptive analysis and transportation pattern

The sample observed has the following sociodemographic characteristics: 65.1% of respondents are female, they are on average 25 years old, 98.4% live with their family and the average of household income is $6,200 BRL per month. ($1,174 USD). About half of the respondents perform some formal or informal work activity in parallel with under-graduation course. Table 1 compares the sample and population characteristics, and although the sample is considered small, its similarity with the population confirms its representativeness.

Based on residences post code informed by respondents, we concluded that, according to PT availability in metropolitan area of Rio de Janeiro (PMCRJ, 2017), 66.7% of respondents live in neighborhood supplied only by bus, 19.0% have access to bus and rail, 7.1% live in a neighborhood served by bus, rail and BRT (Bus rapid transit), 3.2% have access to bus and BRT, 2.4% are served by bus and subway, and only 1.6% live in a neighborhood supplied by bus, rail and metro. Regarding to trip distance from home to university, 22.3% of sample declared to travel less than 1 km, followed by those who travel less than 20 km (39.7%), less than 40 km (19.8%), and more than 40 km (18.2%) as shown in Table 2.

Table 1 - Sociodemographic characteristics (sample vs population)

Characteristic	Group	Sample %	Population %
Age	*Mean*	25.00	23.00
Gender	Female %	65.08	63.60
Occupation	Worker-student %	56.20	22.70
Living arrangement	Family %	98.41	98.70
Household income per month	*Mean*	6,200	6,659

Note[1]: 1.00 USD = 5.28 BRL (May 13, 2021)
Note[2]: Sample size: 126 / Population: 16,000

Table 2 – PT availability in house neighborhood and travel distance to UFRRJ

Variable	%
PT available in the student's house neighborhood	
Bus only	66.7
Bus and Rail	19.0
Bus, Rail and BRT	7.1
Bus and BRT	3.2
Bus and metro	2.4
Bus, Rail and metro	1.6
Distance from home to campus	
< 1 km	22.31
1 km - 10 km	26.4
10 km - 20 km	13.2
20 km - 30 km	12.4
30 km - 40 km	7.4
40 km - 50 km	8.3
> 50 km	9.9

Table 3 - Trip pattern (frequency per week %)

	Never or rarely	Once or twice	3 or 4 times	5 times or more
Mode choice				
Car	55.21	17.71	10.42	16.67
Motorcycle	93.75	2.08	-	4.17
Bus	13.54	10.42	12.50	63.54
Rail	75.00	8.33	5.21	11.46
metro	83.33	6.25	3.13	7.29
Walk	71.88	8.33	6.25	13.54
Cycle	95.83	3.13	-	1.04
Cycle + PT	96.88	1.04	1.04	1.04
Trip interation (alone or with someone)				
Alone	4.17	8.33	15.63	71.88
With couple	60.42	20.83	6.25	12.50
With parents	89.58	3.13	1.04	6.25
With children	97.92	-	-	2.08

Regarding to trip pattern, as reported in Table 3 the most used mode is bus: 76% of students go by bus to the university at least 3 times a week, and those who commute exclusively by bus

are 63%. Concern to car use, half of the participants never or rarely go by car to the university while less than 20% use the car five days per week. Regarding to subway, although 16.7% of respondents stated that they use metro to go to the university at least once a week, it should be noted that UFRRJ campuses are not served by this mode. Later, the interviews clarified the metro is used in association with other modes, such as rail or bus. About active modes (walking and cycling), about 80% of students rarely or never go to the university by walking and most of them rarely or never use a bike on commuting, either alone or associated with PT. Motorcycle is also rarely used, since less than 10% of students declared to use it on commuting.

4.2. Factor analysis: relevant aspects for mode choice

Aiming to identify the most relevant factors that drive the students in their commuting mode choice, aspects related to transit education and courtesy, accessibility, comfort, security, travel time and cost, reliability and service performance were addressed in 22 statements on a 5-point Likert type scale.

Data analysis was performed using Exploratory Factor Analysis method (EFA), with extraction of factors by Principal Component Analysis method (PCA) and Varimax rotation, whereby 4 factors were retained to explain the 22 variables, according to their factor loadings (a). Bartlett's sphericity (1006.4, gl = 231, $p < 0.001$) and KMO (0.830) measures suggest the sample adequacy for factor analysis, and the survey reliability (Cronbach's Alpha = 0.890) is considered good (Field, 2018). The anti-image matrix shows significant correlation for all the variables (> 0.500) and the matrix of variance explained shows that 59.16% of total variance is explained by the 4 factors.

Table 4 – Factor loadings (a) of attributes for mode choice

	Customer service	Comfort	Safety	Reliability
Traffic education (behavior of drivers, pedestrians)	0.872			
Traffic signs (direction signs, pedestrian crossings)	0.859			
Cordiality of staff	0.824			
Customer relationship service	0.717			
Access for people with reduced mobility	0.704			
Risk of assault or harassment	0.651			
Vehicle cleanliness	0.521			
Timetable and itinerary information	0.511			
Easy parking	0.498			
Music on board		0.775		
TV on board		0.753		
Free wi-fi on board		0.736		
Perceived noise during the trip		0.641		
Risk of accident			0.823	
Risk of service disruption			0.759	
Vehicle physical condition			0.554	
Security at bus stop or station			0.541	
Waiting time at the bus stop or station			0.478	
Trip duration				0.806
Arrival at the destination without delay				0.675
Cost				0.575
No excessive transfers				0.403

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 6 iterations.

The arrangement of variables in each factor denotes the coherence of the matrix to the model proposed by Allen et al. (2019), which categorizes the attributes of the mode choosing in

functional, safety and hedonic. Functional aspects are related to everything that is minimally necessary for the provision of the service, such as reliability, accessibility, mobility, frequency, speed and essential comfort. Safety aspects involve attributes related to risk of accidents and assaults, risk of service disruption, protection against environmental hazards and weather conditions. Finally, hedonic attributes are related to abstract aspects, which can be perceived by users as something extra and positive, such as wireless connection, air conditioning, cleanliness and physical condition of the vehicle, noise, smell, aesthetics, convenience and ease of use, access to information and customer service, courtesy of the staff (Allen et al., 2019). The factor loadings matrix can be observed in Table 4.

The first factor represents the customer service concerns. It is composed by 9 variables, and it explains 23.56% of variance. Its most relevant item is “Traffic education” (a = 0.872). The surprising finding of this factor is given by the item "Risk of assault or harassment" (a = 0.651), commonly classified as an aspect of security, but in this survey attributed to customer service, which indicates that the perception of security is different and derives from the context, as verified in the interviews, where this issue was related to waiting time at the bus stop, which suggests that the risk has been understood as a result of the low quality of the service.

The second factor concerns the attributes related to comfort and it explain 13.43% of variance. It is composed for 4 items, and it has three variables with very similar factor loadings (0.736>= a <= 0.775). Their variable with lower factor loading is “Perceived noise during the trip” (a = 0.641) - as the factor is related to the perception of extra comfort, the perceived noise is expected to be less relevant than amenities offered during the trip. The similar factor loading among the aspects related to extra comfort suggests that some amenities may be used as a differential to encourage the use of a public transport. In contrast, the interviews revealed that, although students want to have more comfort in their daily commuting, there are more urgent needs to be satisfied before it, such as travel time and safety. This finding suggests that the Theory of Human Motivation can be useful to propose hierarchy in transportation solution modeling.

The third factor is related to security and protection attributes. It explains 12.64% of variance and its most relevant item is “Risk of accident” (a = 0.823). Although the variable " Waiting time at the bus stop or rail/metro station" (a = 0.478) is commonly classified as a functional attribute, its imputation in a safety factor reveals an association with vulnerability and risk during the waiting which suggests that its interpretation varies according to security perception in different contexts. The classification of “vehicle physical condition” as a safety attribute suggests its interpretation was related exclusively to risk of accidents.

The last factor, related to functional aspects, explains 9.52% of variance and aggregates attributes as speedy, reliability, cost and mobility, being the most important item “Trip duration” (a = 0.806). The classification of travel time as a functionality was confirmed by the interviews, since respondents reported that it is the most relevant aspect for commuting decision. Regarding the cost not having been classified as a very important factor and having been cited in the interviews as an important one, it suggests the difference between the real mode decision, reported in the interview, and the ideal decision, reported in the survey, in which people admit, in a hypothetic situation, to accept paying more for a higher level of service.

4.3. Interviews

As previously mentioned, an online semi-structured interview was carried out with 10 subjects

of the sample, aiming to confirm the data provided in the survey and obtain detailed information on travel habits and perceptions about the transport system, as well as verifying the effectiveness of the instrument of data collect. The interviewee's profile is reported in Table 5.

Table 5 - Interviewee's profile

Name	Gender	Age	Occupation	Home vs campus Km)	Main mode	Trip duration
Alessandra	Female	21	Student	42	Car	45m - 1h
Rodrigo	Male	23	Worker-student	60	Rail, metro, bike	> 1h 30m
Evandro	Male	33	Worker-student	43	Bus	< 30m
Júlia	Female	21	Student	50	Bus, rail	> 1 h 30m
Micaela	Female	18	Worker-student	23	Bus	1h - 1h 30m
Rosana	Female	20	Student	17	Bus	> 1h 30m
Carolina	Female	22	Student	55	Bus	1h - 1h 30m
João	Male	22	Worker-student	55	Bus, rail	> 1h 30m
Leandro	Male	22	Worker-student	52	Bus	> 1h 30m
Vicente	Male	21	Student	10	Car	< 30m

Note: The interviewees' names were changed.

In addition to supporting factor analysis, the interviews provided important insights about the students' commuting, their perceptions about safety, cost and level of service. In general, the interviewees demonstrate being conscious of hedonic aspects of mobility, such as its social role, the lack of accessibility in the suburbs, and the relationship between transport and environment. These statements corroborate the exploratory factor analysis, in which aspects such as traffic education, cordiality of providers (a >0.800), availability of a customer relationship service (a = 0.717) and access for people with reduced mobility (a = 0.704) were gathered at the first factor.

"We are segregated by transport. While in richest neighborhoods there is public transport in good condition, reliable schedules, and comfortable vehicles, the suburb suffers from the negligence of authorities, the lack of buses and metro, unreliable schedules, vehicles in bad conditions" (Carolina, 22, works 55 km from UFRRJ).

"It is important to discuss the transportation system. While a car carries up to 5 passengers, a bus carries 45 seated passengers. If everyone uses public transport, we would not only solve the mobility problem, but we would also reduce emissions" (Leandro, 22, works 52 km from UFRRJ).

Regarding to extra comfort items, as music and free wi-fi on board (a > 0.700), the interviews confirmed that these attributes are less important than trip duration (a = 0.806). It means that a hierarchy of needs is taken into account on commuting decision, since for most of interviews travel time and cost are the main factors to be satisfied. Summarizing, although respondents recognize the importance of comfort during the trip, they admit that arriving on time for classes is more urgent.

"The objective is to arrive at the university on time for classes. Comfort comes second" (Rosana, 22, lives 17 km from UFRRJ).

"Comfort is also important. (...) However, going to university, there is no choice, I need to get there fast" (João, 22, works 55 km from UFRRJ).

Regarding to the variable "Cost", although it was not reported as a relevant attribute in the factor analysis (a = 0.575), interviewees demonstrated its relative importance on transport decisions, either by the need to reduce it or by admitting that people would accept to pay more for a higher level of service.

“If we invest more in public transport, people will use public transport and they will even accept to pay more for comfort, quality and reliability” (Carolina, 22, works 55 km from UFRRJ).

All respondents said they plan their daily commute in detail. All of them had tested various combinations among modes of transport and routes, before defining the one to be used frequently.

“I tried public transport at the beginning of the graduation. The high cost, the delay and the risk of assault made me choose to ride with my father” (Vicente, 21, lives 10 km from UFRRJ).

"I have already tested various combinations of transport to go to university. I chose the bus which, despite being more expensive and less comfortable, is faster" (Leandro, 22, works 52 km from UFRRJ).

In addition, all of them stated taking into account the experiences of peers in their decision making about commuting. Some of them criticized people who form their opinions based on the experience of others and those who are reticent to use public transport. The only interviewee who does not use PT to go to university admitted that his opinions are based on the narratives of colleagues and relatives.

"I don't use public transport, but I know it's terrible, because my colleagues complain a lot, and they are always late for classes. " (Alessandra, 21, lives 42 km from UFRRJ).

“There are people who have never used public transport. They don't know where a metro station is. They usually hear bad things about transport and build their opinions based on the experiences of other people” (Carolina, 22, works 55 km from UFRRJ).

Safety-related aspects were also widely mentioned in the interviews. For some interviewees, lack of security is a common reality in Rio de Janeiro and, despite admitting that they feel vulnerable in transport, they say they are used to the risk of assault and harassment. This observation may justify the fact that the "risk of assault and harassment" has been classified, in the factor analysis, as an attribute of customer service rather than a security one.

“Unfortunately, episodes of assaults and harassment at the bus stop [next to UFRRJ] are not rare. Professors usually finish classes earlier for safety reasons and, when we all avoid walking alone” (Júlia, 21, lives 50 km from UFRRJ).

"We use carrying the thief's money in the pockets and, when he arrives, we promptly give him the money” (Rodrigo, 21, works 60 km from UFRRJ).

All interviewees agree that public transport in metropolitan region of Rio de Janeiro needs to be reformulated and the excessive transfers and long journeys reported by students underline the weaknesses of the transportation system in the region.

“Despite living close to UFRRJ, I need to take two buses to get to campus. It has already taken 2 hours to arrive because of congestions” (Vicente, 21, lives 10 km from UFRRJ).

"I wake up at 4:20 am, take my own bicycle to the train station, take the train at 5:20 am and arrive at the center of Rio [de Janeiro] around 6:40 am. There, I take the metro to Botafogo and there I ride a sharing bike to get to Urca, where I work. I've already tried other ways of commuting and this is the one that gives me the best experience" (Rodrigo, 21, works 60 km from UFRRJ).

Despite admitting the transport system's negative impact on their academic life, students say that transport problems cannot make them give up on their objective of graduating.

“I missed some classes because I was tired and I didn't want to face the commuting, especially on rainy days, but giving up never crossed my mind. We must believe that everything is gonna be alright” (Júlia, 21, lives 50 km from UFRRJ).

"I've thought about giving up many times. But I spread the course over more years so that I can sleep in the office two or three times a week. It will take longer to complete my graduation, but it was the strategy I used to reduce my weekly commuting, feel less tired and don't stop studying" (Rodrigo, 21, works 60 km from UFRRJ).

The interviews also revealed some weaknesses of the survey: (i) since the combination among the various modes of transport, instead of only between bike or scooter and PT, was not been included in the survey, some respondents informed as usual mode of commuting the mode used in the longest stretch of the daily trip. As consequence, for example, the metro was stated as an option of commuting to university, although none of UFRRJ campuses are served by this mode; (ii) the instrument did not consider the ownership of car (only its use), which limited the analysis of travel behavior; (iii) the inversion of Likert scale statements in some questions, aiming to check the attention of respondents, was identified for one of the interviewees as "uncomfortable" and "harmful", which corroborates the literature about problems commonly related to Likert scales, namely the influence of the order of alternatives, tendency of agreement, central tendency, and adoption of standardized response (Brace, 2008; Bradburn et al., 2004); (iv) the number of questions (n = 164) impacted the response rate, lower than expected, and the quality of the answers, indicators that measure, respectively, the level of motivation and interest of the participants related to a research topic (Brög, 2015).

5. CONCLUSION

Based on Theory of Planned Behavior and Theory of Human Motivation, a pilot survey and some online interviews were addressed to UFRRJ students in order to identify relevant factors for their commuting decisions and to collect their perceptions about the transportation system in metropolitan region of Rio de Janeiro.

Regarding the representativeness of the sample, although 126 responses represent less than 1% of UFRRJ students, this response rate is acceptable for a pilot survey, since its demographic similarities with the population indicate that the sample contributed to achieving the objectives of the study. However, since the survey was published in the last week of the 2019's academic year, when students are usually dedicated to final assessments, it suggests reduce availability and interest in participating in other activities. Likewise, the invitation for interviews was sent in the first week of the 2020's academic year, usually dedicated to the reception of new students, with low participation from others. Both experiences suggest that, at least in case of UFRRJ, the response rate is strongly dependent on the time of school year in which the survey is applied, and different dissemination strategies for the next data collection instrument are required.

The exploratory factor analysis results corroborate the existence of a hierarchical classification of transportation needs as proposed by the literature. However, on the opposite to literature suggestions, in the present study some hedonic aspects, as education and cordiality, were considered more relevant than those associated with safety and functionality, such as risk of accident. This contrast supports the hypothesis that the hierarchy of transport needs is strongly influenced by the context observed, while reveals its potential role in transport policies design on demand.

Regarding the supply of public transport, both in the exploratory factor analysis and in the interviews, a structural limitation and lack of connectivity among available modes of transportation was evidenced. Since bus is the most used mode for commuting to UFRRJ, the dependence of a single mode increases commuting time, costs and the number of transfers,

which can negatively impact academic performance, students staying longer than expected and the risk of college dropout.

While Exploratory Factor Analysis was used to identify the relevant attributes to commuting decision, the interviews were more effective in exploring perceptions about the transportation system, which confirms the complementarity between both data collection instruments. According to the interviews, students use to test various modes and combinations before deciding on a mode to daily use and when a commuting pattern is validated and adopted, it is supported to ensure the achievement of a main objective, which is to arrive on time for classes. In addition, the students take into account the opinion and experience of colleagues to support their choices. This finding corroborates the three pillars of TPB: attitude, subjective norm and perceived control.

As stated before, the findings support the achievement of the research objectives and highlight its limitations, as well as confirming its role as the first stage of a broader research. As next steps, the Theories of Planned Behavior and Human Motivation, as well as the results obtained in this first stage, should support the new questionnaire, to be submitted to UFRRJ students. The next data collection instrument should also consider new elements, such as the Covid-19 pandemic. the two consecutive years on remote teaching, the absence of daily commutes, and their impact on travel behavior of students.

Finally, in a broader sense, the present study highlights the importance of behavioral research and citizen participation in designing of public policies, as it confirms the effectiveness of the Theory of Planned Behavior for research on travel behavior and defends the usefulness of the Theory of Human Motivation for a hierarchical interpretation of the attributes taken into account in travel decisions.

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