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Satisfaction with public transport: the case of an university access

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ABSTRACT
This study presents the results of a diagnostic survey on the users satisfaction with the public transportation system which enables access to a higher education institution (HEI), relating it to some socio-bio-demographic characteristics. The research instrument, based on fuzzy logic, was answered by 184 randomly selected passengers. The statistical analysis was performed with non-parametric tests (Kruskal-Wallis, Man Whitney, Friedman and Wilcoxon). The results for the level of satisfaction were considered reasonable and it was identified that the factors "terminal/stops" and "comfort/service for passengers" were the worst evaluated. It was also identified that the age of the passengers, travel time and distance from the terminal/stop to the origin/destination are associated with the level of satisfaction.
Keywords - quality; satisfaction; urban mobility; transportation systems; public transportation.

I. INTRODUCTION

According to Carvalho and Miranda [1], just over 60 years, the urban travel in major Brazilian cities were carried out by collective public modalities, while the individual motorized transport was insignificant. However, in the beginning of the 1970s, population growth and rural exodus have turned the country into predominantly urban. As a result, there was a disordered development of cities with major impact on transport systems.

Since then, the amount and diversity of urban mobility problems have been growing. In Brazil, most cities face difficulties to encourage the use of public transportation. There is an increase of the number of private vehicles and, consequently, an increase of traffic jams, accidents, environmental pollution and travel time disproportionate to the distance traveled, among others.

Data from DENATRAN [2] are alarming because state that, currently, the Brazilian fleet of cars is nearly 50 million, which corresponds to approximately one vehicle per four inhabitants. This accelerated growth in the number of private vehicles may be associated with the low level of satisfaction with public transport, which was revealed by IPEA [3] as the worst among all the country's ways of transportation.

The public policies adopted by cities, which prioritize the automobile at the expense of public transportation, may also have contributed to the aggravation of this problem. According to Bertucci [4], besides the Brazilian model of mobility being focused on the automobile, the main measures to solve the problems of this nature usually involve the creation of overpasses or the expansion of highways. Few rulers see in an efficient public transportation system, i.e. that meets the needs of its passengers, a possible solution for those adversities [4].

It is imperative, therefore, the implementation of actions to make the public transport efficient, maximizing its use. Among these actions is the measurement of passenger satisfaction, which can be seen as a consequence of the quality offered by the transport system service. If the passenger is satisfied while using it, and is going to reuse it whenever necessary, he may disclose his opinion and influence the behavior of others, increasing the use of the transport system.

Therefore, carrying out studies for measuring consumer satisfaction with the public transportation system can improve its performance, making it more attractive to passengers. Several methods have been proposed to find ways to improve it. The most cited in the literature, as reference studies and planning related to transportation, is the Transit Capacity and Quality of Service Manual [5].

This paper, besides comment on some studies developed to measure the satisfaction of passengers on public transport systems, aims to present the results from a satisfaction diagnostic survey of users of a public transportation system that

enables access to a higher educational institution (HEI). The objective is to also show its relationship with some socio-bio-demographic characteristics, making sure that these variables influence the perception of the passengers regarding the quality of the public transport system.

II. THEORETICAL BASIS

Within the area of urban and interurban mobility, many studies, some of which are quoted below, have been developed to assess passenger satisfaction of a public transport system, highlighting the importance of the issue.

Rubinstein [6] evaluated the quality of the public transportation system offered in Montevideo/Uruguay, by means of conventional type bus, measuring user awareness regarding quality characteristics and their satisfaction. Using the Probit model, he identifies as important factors: system reliability, comfort of vehicles and other infrastructure, safety, economy, comfort during the travel, passenger information systems and system features. The sample was composed by 528 people, showing a slight predominance of female passengers (55%), and more frequent age between 36-50 years (27%). The results showed that passengers are satisfied with the facilities offered by the public transport service and the vehicle characteristics. However, there is dissatisfaction with the system reliability, comfort during travel due to the large capacity, fare and security.

Tyrinopoulos and Antonion [7] developed a methodology to assess the public transport user satisfaction, covering subway and various bus types. It was tested in five management systems operating in two cities in Greece (Athens and Thessaloniki). They interviewed 1474 people who assigned scores to a list of items reflecting their importance according to satisfaction and performance. A factorial analysis shows that four of the five systems considered the most important items are those related to quality of service, quality of travelling and service production, existing differences by gender. The other system also considered important the items related to information/courtesy. A logistic regression identifies frequency of travels, vehicle cleaning, waiting conditions, travelled distance and coverage as top rated items. However, these items are different between the systems, since, according to the authors, their characteristics and processing conditions affect the performance of the transport system and, consequently, the consumer's satisfaction.

Ji and Gao [8] proposes to assess the urban structure using the passenger's satisfaction with public transport service, linking it to some socio-bio-demographic characteristics. It was identified that career, family income, age, travel time and distance from bus stop to the places of origin / destination are associated with the level of satisfaction. Low satisfaction levels are associated with higher family income, short travel time (less than 30 min.), as well with an intermediate age group (40 to 60) and further away bus stops (over 800m) from source destination. Liberal professionals tend to be more satisfied. The authors conclude showing that the results can subsidize the planning of transportation systems.

Shaaban and Khalil [9] investigated the satisfaction of the bus service users in Doha / Qatar in order to assess the quality of the service and make recommendations that could maximize the use of buses in the city. The instrument included questions concerning general information of passengers, other modes of transportation used by them and their perceptions regarding the quality of the bus service. The sample consisted of 278 passengers, mostly men (84.89%), with 45 years or less (88.49%) and residents in Qatar (91.73%). In addition, most of them had no car (67.27%), placing this as the key reason for using the public transport (59.71%). Regarding the user's satisfaction with the bus service offered, most said the bus stations are in poor condition (54%), with poor accessibility (60%) and a few covered areas to protect people from climatic conditions (60%). However, almost 60% of passengers consider the security, noise, crowd and cleanliness of the stations as good. As for the satisfaction with the overall quality of the vehicle, most showed satisfaction with the safety, cleanliness and fare of the bus (66%). Also, respondents were satisfied with the preparation of drivers regarding the respect for traffic laws, appearance, courtesy and discretion. However, punctuality and frequency were critically emphasized as inadequated.

Noor et al. [10] conducted a study aiming to identify the determinants of satisfaction of bus users in the city of KotaKinabalu / Malaysia. In this city, there is the transit of two types of buses: common bus and mini bus. The latter is a more compact vehicle which, despite allowing the transportation of a smaller number of passengers, moves faster through the highways and can travel distances in a shorter time. The sample consisted of 987 people, which should evaluate 24 attributes related to bus services. The results were submitted to factor analysis, which defined three factors: comfort, accessibility and safety. The authors concluded that the population is more satisfied with the services offered by mini bus, especially regarding the waiting time, coverage and punctuality. However, there is dissatisfaction with the comfort of the vehicles.

The study by Wakata et al. [11] was made in order to appraise the perception of the passengers on the safety of the subway service in the city of Burean /Japan. The instrument considered ten items

(regularity, education with customers, transfer between trains, comfort at the station, opening and closing doors of the vehicle safety control system, persistence, crime prevention, cleanliness and staff service) that are often used in instruments that measure passenger's satisfaction. The sample consisted of 404 peoples. First, they assessed their sense of security when using the metro service. Then, they should evaluate the importance of each item for their safety. The study results showed that most of the respondents show some sign of insecurity (56%), being possible to relate the level of safety with the importance of the items. For example, fully secure people tend to choose as the most important item cleaning, while insecure people look for items such as train transshipment and crime prevention.

Hashim et al. [12] evaluated the satisfaction of students who use public transport to access the campuses of higher educational institutions in Malaysia. The sample consisted of 5883 respondents from twelve different universities. The majority of respondents who use public transportation within the campuses were women. They evaluated 29 items related to satisfaction. The best evaluated were the route used by buses and the state of the access roads to the campuses, while punctuality, credibility and bus shelters were evaluated as worst. The study found that the bus service is satisfactory. However, the authors stressed that it is important for Malaysian educational institutions to increase investment in mobility within the campuses, in order to reduce the use of private cars and encourage an environment with the use of sustainable options such as walking and cycling.

III. METHOD

The population of this study consists of the users of an urban public transport system which enables access to a campus of a higher educational institution (HEI).

A sample of 184 passengers was randomly chosen through random conglomerate sampling in multiple stages. Initially, we randomly selected two days a week and some rooms in the buildings of the mentioned campus, also randomly selected. If the selected room is a classroom, the instrument is applied during a lecture in each of the three shifts: morning, afternoon and evening. Otherwise, the survey is made in the afternoon. All people who are present in the locations selected at the time of the data collection and use public transport on their way to the campus of the institution are invited to participate.

The instrument used, proposed and validated by Mattos et al. [13], is based on fuzzy logic to measure the passenger satisfaction level with the public transportation system. In addition to the identification data, the instrument has 22 items, grouped into four factors: "comfort/relationships", "terminal/stops," "characteristics of the vehicle" and "driver's skills." The respondent must assign a score to each of these items to reflect his level of satisfaction. Also, he must assign a score to each factor that reflects its importance to his satisfaction with the service used. In the interpretation of the results, it is possible to get a score that may be associated with five levels of satisfaction, defined by fuzzy sets, as Fig 1.
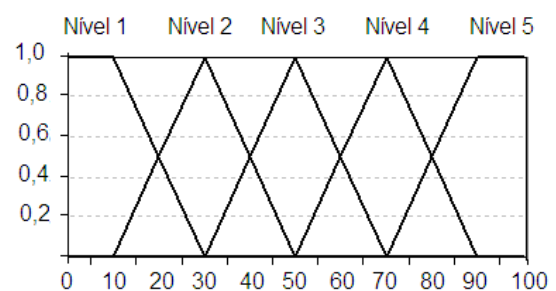

Fig 1 - Criteria to interpret the scores for satisfaction level.

In order to know some data properties (central tendency, dispersion, asymmetry, kurtosis and the presence of outlier, among others), an exploratory analysis was initially performed, using analytical and graphical methods. This analysis was performed on the data representing the level of satisfaction as well as on the data obtained for the importance of each factor used in the construct measurement and, also, on the scores assigned to them in their assessment. Friedman tests were used to compare them. When the difference is significant, several Wilcoxon tests were used to locate it. The significance's level in the analysis is 5%.

Later on, it is evaluated the association of the results with some socio-bio-demographic and technical characteristics: gender, age, family income, time of studying in the university, distance from the source/destination to the terminal/stops and travel time. Kruskal-Wallis test and Man Whitney test are used in these analyses. When an association between level of satisfaction and some socio-bio-demographic variable is identified, similar analysis is made for the importance given to each factor, as well as to the scores given in its assessment. The considered significance's level is also 5%.

IV. RESULTS AND DISCUSSION

Observing the socio-bio-demographic data, we see that the sample is composed by a greater number of male passengers (59.2%), under 25 years old (80.4%) and family income between US$ 1.000,00 and US$ 3.750,00 (49.5%). Mostly of them is not studying at the institution for more than four

semesters (63.7%). Among the respondents, the most common scenario (40.9%) is the terminal/stop being close to their residences (less than 200m) and (48,9%) the long travel time (between 31 and 60 minutes), considering the city's size. This result agrees partially with the study proposed by Shaaban and Khalil [9], in which half of the sample of bus service users in Qatar said they take over 30 minutes of travel time.

Statistical analysis is performed using nonparametric techniques, due to the use of the fuzzy metric. An exploratory analysis of the data found for the level of satisfaction identifies significant negative asymmetry $(k_3 = -0,99 ; EP_{k3} = 0.18)$ and leptokurtic distribution $(k_4 = 0,97 ; EP_{k4} = 0,36)$, as well as seven possible nonstandard lower values. Graphical methods confirm these findings.

The passenger's satisfaction level varies between 5 and 95, with median $Md = 69,95$, first quartile $Q_1 = 58,49$ and third quartile $Q_3 = 81,18$. By the fuzzy linguistic terms considered in the instrument, the average level of satisfaction can be considered level 3 with membership degree 0.0025 and level 4 with membership degree 0.9975, which is reasonable. In surveys on customer satisfaction, it is a common practice to consider only as satisfactory results the ones obtained in the highest category of the scale considered, in that case "level 5". In this study, 49.5% of passengers could fit under this category with different membership degrees. However, only 11.4% fit with membership degree 1.0.

The summary measures of the scores attributed to the four factors are presented in Table 1.

Table 1 - Summary measures of the assessments of the factors that measure the level of satisfaction.

Meas.	comfort and relationship	vehicles chracteristics	terminal/stop	driver's skills
X_{min}	5,0	5,0	5,0	5,0
Q_1	57,3	67,8	50,0	64,2
Md	70,0	80,5	67,1	82,6
Q_3	82,5	95,0	82,5	95,0
X_{max}	95,0	96,3	95,0	95,0
dq	25,2	27,2	32,5	31,2

The Friedman test is used to compare them and finds evidence of a difference between the results $(\chi^2_{calc} = 82,99 ; gl = 3; p-value < 0,0001)$. The Wilcoxon test, which is used for multiple comparisons, finds evidence that the worst rated factor is "terminal/stop", which is government's responsibility, followed by "comfort and relationship," that is responsibility of the company in charge of the transportation system. The factors "characteristics of the vehicle" and "driver's skills," best evaluated, are considered similar.

The summary measures of the scores given to the importance of each factor are shown in Table 2.

Table 2 – Summary measures of the scores given to the importance of factors that measure the level of satisfaction.

Meas.	comfort and relationships	vehicles characteristics	terminal/stop	driver's skills
X_{min}	2,0	1,0	0,0	0,0
Q_1	67,0	70,0	70,0	70,0
Md	87,0	80,0	90,0	100,0
Q_3	95,0	100,0	100,0	100,0
X_{max}	95,0	100,0	100,0	100,0
dq	29,0	30,0	30,0	30,0

The Friedman test finds evidence of difference between the scores given to the importance of the factors that measure the level of satisfaction $(\chi^2_{calc} = 22,15 ; gl = 3; p-value < 0,0001)$. The Wilcoxon test identifies the factor "comfort and relationship" as being less important to the passengers than the factors "terminal/stop" and "driver's skills." In the study proposed by Shaaban and Khalil [9], it was also highlighted the issues of conditions of boarding stations and the ability of the driver. As for the terminal/stop, 54% of respondents complained about the poor condition of the stations, where there is no covering to protect against weather and there are no seats for customers to use while waiting for the bus. In this study, the respondents were satisfied with the issues concerning the skills of the driver, knowledge of traffic regulations, the driver's appearance, courtesy and discretion.

The comparison of the satisfaction levels by gender, using the Mann Whitney test, finds no evidence of difference between the distributions $(z_{calc} = -0,45 ; p-value = 0,649)$, the same applies to the time of studying in the university. In terms of

age, the same test found evidence that the younger, under 25 years, have a higher level of satisfaction $(z_{calc} = -2,36 ; p - value = 0,018)$.

The Kruskal-Wallis test did not find evidence that the level of satisfaction is related to family income $(\chi^2_{calc} = 1,53 ; gl = 2; p - value = 0,465)$, disagreeing with Ji and Gao [8], the same does not happen in relation to the distance to the terminal/stop $(\chi^2_{calc} = 11,57 ; gl = 4; p - value = 0,021)$ and travel time $(\chi^2_{calc} = 9,33 ; gl = 3; p - value = 0,025)$, agreeing with Ji and Gao [8].

In the comparisons developed with the Mann-Whitney test it is possible to find evidence that passengers who walk a greater distance (over 800 m) to the terminal/stop have lower satisfaction levels, agreeing with Ji and Gao [8], as do those that take a longer travel time (over 60 minutes), disagreeing with Ji and Gao [8].

Kruskal-Wallis tests are applied to the partial results, attributed to the importance of each factor, and do not find evidence that these results are associated with the distance to the terminal/stop, nor with travel time, disagreeing with Tyrinopoulos and Antoniou [7], which identified that men and women build this construct differently.

When the association with the assessment assigned to each factor with these variables is analyzed, it is found evidence that only the factor "comfort and relationship" $(\chi^2_{calc} = 10,18 ; gl = 4; p - value = 0,037)$ is associated with the distance to the "terminal/stop". Passengers who identify the distance as greater than 800m evaluate it worse. Regarding the travel time, it is find evidence of association between "comfort and relationship" $(\chi^2_{calc} = 10,25 ; gl = 3; p - value = 0,017)$ and "driver's skills" $(\chi^2_{calc} = 8,13 ; gl = 3; p - value = 0,043)$. Passengers who make longer trips tend to rate them worse.

V. CONCLUSION

This study presents the results of a survey of passenger's satisfaction levels of a public transportation system. Overall, the results are considered reasonable, although some weaknesses have been identified, including the infrastructure of the terminal/stop, which is the government responsibility. Regarding the responsibility of the management company, the findings indicate that the level of satisfaction can be increased with the implementation of improvements related to the "comfort and relationship." This factor contains items related to the comfort inside the vehicle, to the passenger treatment and service schedule.

It is important to remember that satisfied passengers can use public transportation more often, and also influence the behavior of others,

contributing to the growth of its utilization rate. In addition, an efficient public transportation system has a great chance to minimize the problems arising from the large number of private cars in circulation.

This study also identifies association between some characteristics of the respondents (age) and the transport system used by them (distance from the terminal/stop to origin / destination and travel time) with the level of satisfaction, showing the importance of their knowledge and monitoring, as a resource for public policy development related to urban mobility. To monitor passenger's satisfaction level is a necessity, especially in the context where this study was developed - an university community - by presenting a big floating population.

A complementary survey is being conducted in order to refine the instrument used in this study, assessing the effect of including items related to routes and pathways, besides the fare cost.

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