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The Urban Transportation Systems in two Cities Located in the Rio de Janeiro State, Brazil

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***Abstract*—**The State of Rio de Janeiro, Brazil, will hold two important events in the nearby future. In 2014 it will have the final game of the Football World Cup, and in 2016 it will be holding the Olympic Games. Therefore, the public transportation system (mainly buses) is of a major concern to the Rio de Janeiro State authorities'. The main objective of this work is to compare the quality of service of the bus companies operating in the cities of ItaperunaandCampos, both cities situated in the state of Rio de Janeiro, Brazil. The outcome of thiscomparison, based on the opinion of the bus users, has shownthemdispleased with the quality of the service provided by the bus companies operating in both cities. It is urgent the need to find possible practical alternatives to minimize the consequences of the main problems detected in this work. With these practical alternatives available, we will be able to offer to the Rio de Janeiro State authorities' suggestions about possible solutions to the main problems identified in this survey, as well as the time of implantation and costs of these solutions.

***Keywords*—**PubicTransportation, Quality of Service, Riders' Opinion, Bus Companies, Practical Alternatives.

I. Introduction

THE State of Rio de Janeiro, Brazil, will hold two important events in the nearby future. In 2014 it will have the final game of the Football World Cup, and in 2016 it will be holding the Olympic Games. So, there is a need to provide public transportation (mainly buses) to a large number of people that will be attending any of these two events. Most of the cities of the Rio de Janeiro State will be accommodating the international and Brazilian tourists during the months of June and July of the years of both events. The cities of Campos and Itaperuna, both located in the Rio de Janeiro State, will be among the ones housing these tourists. Therefore, the public transportation system of these two cities is of a major concern to the Rio de Janeiro State authorities'.

In previous papers [1] and [2], we analyzed, respectively, the transportation systems by buses in the cities of Itaperuna and Campos. The main objective of this work is to compare the quality of service of the bus companies operating in the cities of Itaperuna and Campos, and find possible practical alternatives to minimize the consequences of the main transportation problems detected in both cities.

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With these practical alternatives available, we will then be able to offer to the Rio de Janeiro State authorities' suggestions about possible solutions to the main problems detected in both cities, as well as the time of implantation and costs of these solutions.

II. Collective Transportation System In Brazil

According to the National Urban Transport Association [3] "in Brazil, on average, the public transportation system is carrying 40% fewer passengers then they carried in 1995."This situation creates a vicious circle, shown in Figure 1.

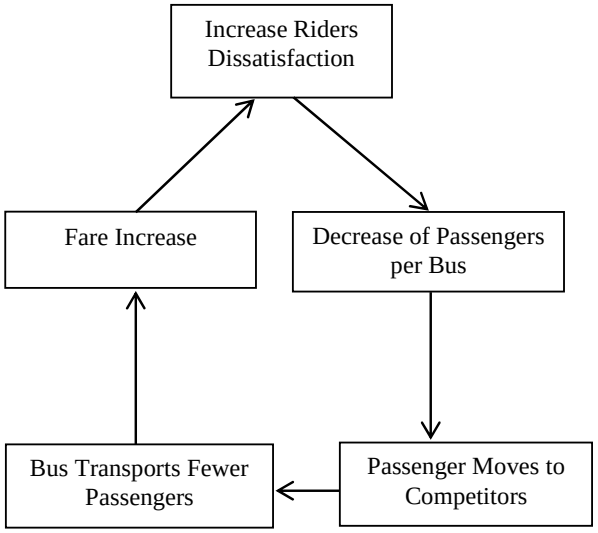

Fig. 1 The vicious circle faced by public bus companies in Brazil

The NPK (Number of Passengers per Kilometer,) in 2003 was approximately 66% lower than in the beginning of the 90's, before the boom in the car industry and the creation of illegal (not authorized) bus or van transport. Another indicator of the decline in bus transport is the average number of passengers transported by day per bus, which at the beginning of the 90's was 600 and has declined to 400 in 2004. As the number of riders decline, the operational cost of the buses falls to the remaining passengers, who become unhappy and more willing to use other transportation options, which powers the vicious circle (National Urban Transportation Association-Yearly Report [4]).

More recently, according to the National Urban Transport Association [5], in the state capitals the number of passengers transported per month in 2009 has shown some stabilization in relation to 2008, even though this number is quite inferior to

the one registered at the beginning of the last decade. This can be seen in Fig.2 below from the National Urban Transportation Association [5].

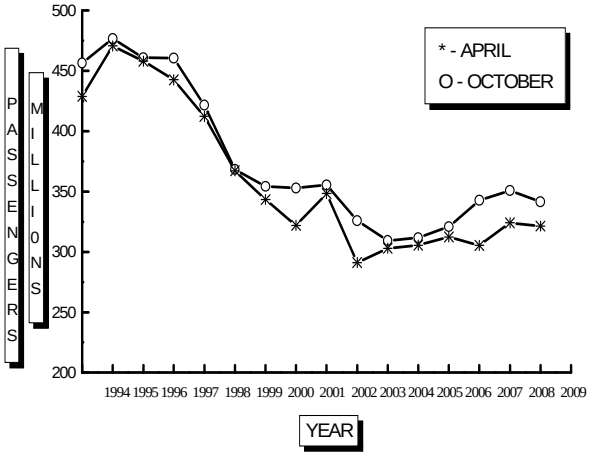

Fig. 2 Number of transported passengers during the months of April and October (1994 – 2009)

III. Methodology

The research method used in this work was a questionnaire asking the customer's opinion about the service given by the bus companiesoperating in the cities ofItaperuna and Campos.From the population of riders in Itaperuna, a random sample of 200 was selected. This research was carried out during the month of October 2010, in the morning, noontime, and again, in the afternoon. From the population of riders in Campos, a random sample of 200 was selected from the seven bus companies operating in that city. This survey was carried out in 2011 during the months of March and April.Tables Iand II below show, respectively, the bus companies' user population and sample data for the cities of Itaperuna and Campos.

TABLEI
Bus Companies' User Population And Sample data (Itaperuna)

Population	Sample
Average of 320,000 passengers/month, or7,272 passengers per day (traveling twice a day for 22 days per month).	200 passengers from the existing bus company

TABLEII
Bus Companies' User PopulationAnd Sample Data (Campos)

Population	Sample
Average of 2,942,684 passengers/month, corresponding to about 66,879 passengers/day (considering that all of them travel 22 days per month, twice a day, outbound and inbound).	200 passengers from the existing bus companies

IV. Results Of This Survey

A. Results Associated with Customer Satisfaction

The results of this survey associated with customer satisfactionfor Itaperuna and Campos can be seen, respectively, in TablesIII and IV for customers per item.

After that, we will present in Tables Vto XXIIthe profile of the bus companies' customer of Itaperuna and Campos. These results will allow us to determine the satisfaction level of all the customers in relation to each one of the items surveyed.

TABLEIII
Questionnaire Results For This Survey (Itaperuna)
Evaluation (200 customers per item)

Conditions	Good	Average	Bad
Average Trip Time	32	99	69
Bus Itinerary	28	88	84
Interval Between Buses	11	48	141
Nº of Buses in the Line	22	80	98
Cleanness	78	101	21
Conservation	67	98	35
Comfort	30	108	62
Safety	31	94	75
Noise and Air Pollution	27	84	89
Fare	5	5	190
Schedule	21	71	108
Employees' Courtesy	69	91	40
Total	421	967	1,012

TABLE IV
Questionnaire Results For This Survey (Campos)
Evaluation (200 customers per item)

Conditions	Good	Average	Bad
Average Trip Time	26	109	65
Bus Itinerary	31	92	77
Interval Between Buses	19	72	109
Nº of Buses in the Line	15	78	107
Cleanness	32	82	86
Conservation	35	74	91
Comfort	25	89	86
Safety	35	93	72
Noise and Air Pollution	25	63	112
Fare	44	77	79
Schedule	50	75	75
Employees' Courtesy	36	99	65
Total	373	1,003	1,024

B. Customer Profile of Itaperuna' Bus Companies

TABLE V
Gender

Gender	Customers % (total of 200)
Masculine	37.0
Feminine	63.0

TABLE VI
Age

Age (years)	Customers % (total of 200)
17 or less	13.0
18 to 25	31.5
26 to 33	23.0
34 to 41	15.0
42 to 49	10.0
50 to 57	2.0
58 to 65	3.0
66 or more	2.5

TABLEVII
EDUCATIONAL LEVEL

Educational Level	Customers %(total of 200)
Incomplete First Grade	9.5
First Grade	1.0
Incomplete High School	21.0
High School	29.0
Incomplete College Degree	19.5
College Degree	20.0

TABLEVII
MANNER OF PAYING FARE

Manner of Paying Fare	Customers % (total of 200)
Pre-paid Discount Card	20.5
Full Fare	61.5
Student	14.5
Free Pass	3.5

TABLEIX
REASONS TO TRAVEL

Reasons to Travel	Customers % (total of 200)
Study	29.5
Work	49.5
Shopping	6.0
Multiple Reasons	15.0

TABLEX
MONTHLY FAMILY INCOME OF PASSENGER (IN EUROS)
1 EURO = 2.28 REAIS

Income (Euros)	Customers % (total of 200)
237 (minimum wage)	21.5
238 to 474	24.5
475 to 711	25.0
712 to 948	7.0
949 to 1,185	6.5
1,186 to 1,422	3.5
1,423 to 1,659	1.5
Above 2,608	5.0
Didn't Know	5.5

TABLEXI
TRAVEL FREQUENCY

Travel Frequency	Customers % (total of 200)
Daily	70.0
Once a Week	0.5
Twice or More a Week	3.0
As Necessary	26.5

TABLE XII
WORST TIME TO TRAVEL IN THE OPINION OF THE CUSTOMER

Worst Time to Travel	Customers % (total of 200)
During the Day	62.0
Night	36.0
Indifferent	2.0

TABLEXIII
WORST DAY TO TRAVEL IN THE OPINION OF THE CUSTOMER

Worst Day to Travel	Customers % (total of 200)
Weekdays	37.0
Weekend	61.5
Indifferent	1.5

C. Customer Profile of Campos' Bus Companies

TABLEXIV
AGE

Age (years)	Customers%(total of 200)
15 or less	11.5
16 to 20	24.0
21 to 25	26.5
26 to 30	8.5
31 to 35	6.5
36 to 40	7.0
41 to 45	6.0
46 to 50	3.0
51 or more	7.0

TABLEXV
GENDER

Gender	Customers % (total of 200)
Masculine	45.5
Feminine	54.5

TABLE XVI
EDUCATIONAL LEVEL

Educational Level	Customers %(total of 200)
Incomplete First Grade	18.5
First Grade	5.5
Incomplete High School	21.0
High School	17.0
Incomplete College Degree	30.0
College Degree	8.0

TABLEXVII
MANNER OF PAYING FARE

Manner of Paying Fare	Customers % (total of 200)
Pre-paid Discount Card	19.5
Full Fare	24.0
Student	33.0
Free Pass	22.0
Didn't Know	1.5

TABLE XVIII
REASONS TO TRAVEL

Reasons to Travel	Customers % (total of 200)
Study	53.5
Work	37.0
Shopping	1.0
Multiple Reasons	8.5

TABLEXIX
MONTHLY FAMILY INCOME OF PASSENGER (IN EUROS)
1 EURO = 2.28 REAIS

Income (Euros)	Customers % (total of 200)
237 (minimum wage)	2.0
238 to 474	8.0
475 to 711	24.0
712 to 948	4.0
949 to 1,185	9.0
1,186 to 1,422	6.0
1,423 to 1,659	11.0
1,660 to 1,896	2.0
1,897 to 2,133	0.0
2,134 to 2,370	10.0
2,371 to 2,607	2.0
2,608 to 2,844	2.0
Didn't Know	20.0

TABLEXX
TRAVEL FREQUENCY

Travel Frequency	Customers % (total of 200)
Daily	82.5
Once a Week	2.5
Twice or More a Week	8.0
As Necessary	7.0

TABLEXXI
WORST TIME TO TRAVEL IN THE OPINION OF THE CUSTOMER

Worst Time to Travel	Customers % (total of 200)
During the Day	44.0
Night	39.5
Indifferent	16.5

TABLEXXII
WORST DAY TO TRAVEL IN THE OPINION OF THE CUSTOMER

Worst Day to Travel	Customers % (total of 200)
Weekdays	33.5
Weekend	60.5
Indifferent	6.0

IV QUALITY LEVEL

Using the results obtained from TablesIII and IV,and applying the same calculation procedure presented in two previous papers[1] and[2], we can determine the overall quality level of the service provided by Itaperuna and Campos' bus companies. These results could be used in the future to evaluate whether the researched bus companies have improved their service and fulfilled their customer's needs.To determine the overall quality level the following steps should be followed:

1. Determine the total number of customers that:

a. S_g; considered the items researched as good;

b. S_{ave};considered the items researched as average;

c. S_b;considered the items researched as bad.

The following weights were used for each of the classifications:

d. Good: $p_g = 2$;

e. Average: $p_{ave} = 1$;

f. Bad: $p_b = 0$.

2. Multiply the obtained values for each of the classifications by its corresponding weights. As a result we will have the overall quality level (OQL) given by (1):

$$OQL = S_g \times p_g + S_{ave} \times p_{ave} + S_b \times p_b \quad (1)$$

Now, with $p_g = 2$, $p_{ave} = 1$ and $p_b = 0$, we will have:

$$OQL = 2S_g + S_{ave} \quad (2)$$

3. Compare the obtained OQL value with the "maximum theoretical value" that (2) could have, that is, the total number of items multiplied by the number of customers surveyed (in both Itaperuna and Campos cases, 12 items and 200 customers researched), multiplied by 2, the corresponding weight for the classification "good." Since in an "optimal theoretical case" all the customers surveyed will give the classification "good" to all the items researched, the value of S_{ave} in (2) will be equal to zero. This comparison is given by:

$$OQL \leq T_V = 2 \times 12 \times n \quad (3)$$

Here, *n* is the number of customers researched (200 in Itaperuna and 200 in Campos), T_V is the "optimal theoretical value" that (3) could have, 2 is the corresponding weight for the classification "good" and 12 is the number of items surveyed in this work. Then:

$$T_V = 2 \times 12 \times n \quad (4)$$

4. Now to compare the obtained OQL value with the "maximum theoretical value" that (2) could have, we will use the following classification:

a. If the OQL value is located between 90% and 100% of the T_V value: the service level is considered to be "good"; the customers' needs are being fulfilled. The bus companies should keep up the good work.

b. If the OQL value is located between 70% and 89% of the T_V value: the service level is considered to be "satisfactory". However, the service level should be improved in order to exceed the customers' expectation.

c. If the OQL value is located between 40% and 69% of the T_V value: the service level is considered to be "reasonable", but there are complaints about some areas of service rendered by the bus companies.

d. If the OQL value is located between 10% and 39% of the T_V value: the service level is considered to be "bad", and urgent measures should be taken by the bus companies in order to continue operating.

e. If the OQL value is located below 10%: the service level is considered to be "very bad". The city authorities should immediately consider canceling the bus companies' concession.

V THE OVERALL QUALITY LEVEL FOR THE BUS COMPANIES

A. In Itaperuna Case

Utilizing the data from Table III and using (2), with S_g = 421, S_{ave} = 967 and S_b = 1012, we will have:

$$OQL = 2S_b + S_{re} + 0 \times S_b = 2 \times 421 + 967 = 1388.$$

Verifying if $OQL \leq T_V$:

$$T_V = 2 \times 12 \times n = 2 \times 12 \times 200 = 4800.$$

As a result,$OQL \leq T_V$, since $1388 \leq 4800$.

Therefore: OQL = 1388, which represents 28.9% of T_V.

This overall quality level (OQL) value of 28.9% is located between 10% and 39% of the T_V value. The service level is considered to be "bad", and urgent measures should be taken by the bus companies in order to raise their level of service.

B. In Campos Case

Employing the data from Table IV and applying (2), here with $S_g = 373$, $S_{ave} = 1{,}003$ and $S_b = 1{,}024$, we will have:

$$OQL = 2S_b + S_{re} + 0 \times S_b = 2 \times 373 + 1{,}003 = 1{,}749$$

Verifying if $OQL \leq T_V$:

$$T_V = 2 \times 12 \times n = 2 \times 12 \times 200 = 4{,}800$$

As a result, $OQL \leq T_V$, since $1{,}749 \leq 4{,}800$

Therefore,OQL = 1,749, which represents 36.4% of T_V.

This overall quality level (OQL) value of 36.4% is located between 10% and 39% of the T_V value. Again, the service level is considered to be "bad," and urgent measures should be taken by the bus companies in order to raise their level of service.

VI Possible Suggestions

The analysis of the survey answered by the bus companies' customers have shown that in both cities all the conditions considered in the questionnaire need to be improved, especially the ones related to interval between buses, noise and air pollution, fare and number of buses in the line.

In Itaperuna, the conditions that were given a "bad" evaluation greater than 48% were:

Fare (95%);

Interval between buses (70.5%);

Scheduling (54.0%);

Number of buses in the line (49.0%).

In Campos, the conditions that were given a "bad" evaluation greater than 48% were:

Noise and air pollution (56.0);

Interval between buses (54.5);

Number of buses in the line (53.5)

The suggestions to the Rio de Janeiro State authorities' for improvement of the main common problemsfor both cities found in this survey are shown in Table XXIII. The condition "Fare" is specific to Itaperuna and the condition "Noise and Air Pollution" is specific to Campos. In some cases the implantation of one suggestion could help in the solution of more than one problem.

TABLE XXIII
Suggestions For Improvement Of The Main Common Problems For Itaperuna And Campos Found In This Survey

Suggestion	Objective	Problems to be Solved	Time of Implantation	Cost
Install a Consumer Service Center	To hear the opinion of the user, verifying what their real needs are	Companies don't know the needs of their users	Short to Medium	Low to Medium
Fare	To improve the welfare of the users	Lack of better fare system	Short	Low
Renew, Increase and Maintain the Fleet	To improve the conditions of the buses, replacing the ones that have exceeded their useful life time	Long wait time, comfort, lengthy intervals between buses.	Medium to Long	High
Best Scheduling and Planning	To decrease intervals between buses	Long intervals between buses	Short to Medium	Low to Medium
Utilize Alternative Fuels	To diminish the effects of noise and pollution of air generated by the bus	Great generation of noise and air pollution	Long	High

VII Conclusions

The bus companies operating in Itaperunaand Campos, both cities located in the state of Rio de Janeiro, need to take urgent measures in order to raise their service level. They should initially focus their efforts on the items that have presented the "worst" evaluation by their customers.The lack of interest by the bus companies on customers' satisfaction is the main reason for the bus companies' customers moving away to informal and alternative forms of transportation, such as: personal car, motorcycle-taxi, private bus and travel by foot or by bicycle. As we have mentioned in previous papers [1] and [2], instead of fulfilling their customers' needs, the bus companies treat them as "captive customers", thinking that their low incomes will exclude private transport and the people will, of necessity, use the bus. This is not the present reality in Brazil due to the economic stabilization Brazil is experiencing in the last ten years. The bus companies need to immediately begin the process of changing their attitude in order to improve the quality of their service. They should focus on customer satisfaction, or their future operations could be bleak. Some of the problems found in this study will demandtime and money to be solved or at least, eased. The bus companies should determine among the analyzed conditions, which ones they could improve in the nearby future by themselves, and which ones will need to have help from the Rio de Janeiro State authorities' to be improved. It must be understood that most of the bus companies' customers in Itaperuna and in Campos are young people, mainly university students and technical personnel. Those people usually are more demanding and, perhaps, the result of the survey applied in this study would be a little more favorable to the bus companies if their customers were people without a higher education.

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