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Analysis of the New Demand-Responsive Transport in Goiânia, Goiás: Citybus 2.0

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ABSTRACT

The demand-responsive public transport Citybus 2.0 was an innovation not only for Goiânia, but for all of Latin America. Created in 2019, this new way of getting around the city is intended to be a substitute for individual motorized transport, encouraging sustainable urban mobility. In order to analyze this new means of transport in the capital of Goiás, an online questionnaire was applied, which had 217 responses, of which 130 are users and 87 are non-users. The questionnaire had ten questions, two of which were general and eight with the purpose of collecting information on user satisfaction regarding the service provided by the new mode of transport. As for the perception of satisfaction, the items related to the cost and service range had the worst ratings.

KEYWORDS: Satisfaction, Transport, User.

1 INTRODUCTION

The right to transport is a benefit guaranteed by the Federal Constitution (FC), according to Constitutional amendment n. 90, of September 15, 2015, amending art. 6 of the FC with a new wording, guaranteeing the social right to all. Transport is something that is part of the daily lives of citizens, as this is, for many, the main means of getting around in an urban area.

Goiânia, capital of the State of Goiás, is a city where transport is an essential element for its residents. From motorized or non-motorized modes. Despite being a social right, not all citizens have access to this service, especially when it comes to public transport.

People who depend on public transport experience several problems in their daily journeys, such as lack of security, old infrastructure, vehicles with excessive numbers of passengers, long journeys and this discourages part of the population from using the service.

With a view to offering public transport alternatives to users in Goiânia, *HP Transportes* created Citybus 2.0 at the beginning of 2019, which is a type of demand-responsive transport (*DRT*), where individuals place their routes on an app installed on their mobile devices.

The Citybus 2.0 project began on an experimental basis, initially covering only the area of the expanded city center, with 14 minibuses in circulation. After approval of the model, which had an average weekly growth of more than 20%, its service area was expanded several times and, less than a year after its creation, it has 79 service districts (RMTC, 2019).

It is a relatively new transport model both in Goiânia and throughout Latin America, as it is the first public and collective DRT service to be implemented (ASSOCIAÇÃO NACIONAL DAS EMPRESAS DE TRANSPORTES URBANOS – NTU, 2019). It has only been nineteen months since its foundation and little is known about the quality offered by this service.

In this sense, the objective was to analyze, through an online platform, responses to a questionnaire elaborated on the satisfaction of Citybus 2.0 users in Goiânia, GO..

2. METHODOLOGY

The research is related to transport in the city of Goiânia, in the state of Goiás, a pioneer in the use of Citybus 2.0. Figure 1 shows the location of Goiás and its capital, Goiânia, where the research was applied.

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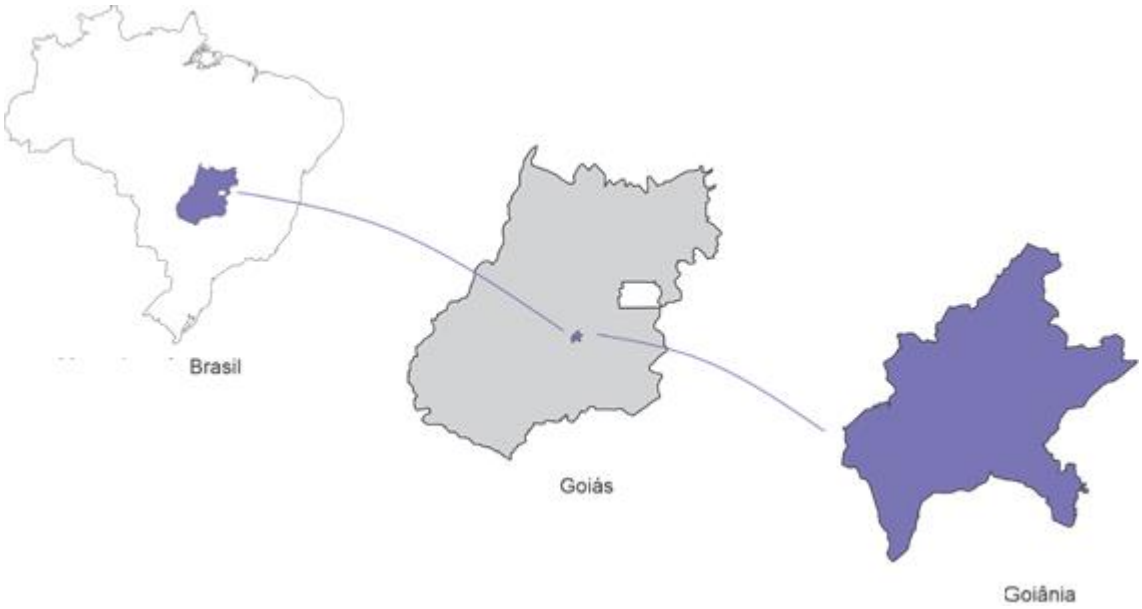
Figure 1: Map of the location of Goiás and the city of Goiânia within the state of Goiás



Source: Prepared by the author.

The research is quali-quantitative, with data collection on the modes of transport present in the capital and also on the period of use of Citybus 2.0, using questionnaires.

The questionnaire was applied to users and non-users of the Citybus 2.0 means of transport and contains ten questions, two questions about the use or not of the transport service and about the possibility of not using the private vehicle to use Citybus 2.0 and the others focused on service quality and user satisfaction.

To the users, eight evaluation questions were added that address aspects related to access, equipment, service provision and perception of safety, quality according to a Likert scale parameter. The Likert scale ranges in its variation from: great, good, regular, bad and terrible.

The questionnaire was administered within a period of thirty days, from September 17, 2020 to October 17, 2020. It was carried out in an unrestricted environment (online), published on social media. Google's online platform was used due to the COVID-19 Pandemic and public health emergency situation by Decree No. 9,633 of March 13, 2020 of the Government of Goiás.

The sample consisted of 217 people, 130 users of the transport system and 87 non-users. As for the analysis of the data obtained, the data regarding users and non-users of Citybus 2.0 was divided.

For non-users, only the first two questions were considered, while for users, all questions were analyzed. For the latter, a table was created with the percentage of responses according to the Likert scale.

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3 RESULTS AND DISCUSSION

3.1 The Main Modes of Transport in the City of Goiânia

Created in 1933, Goiânia is a relatively new city that represented innovation and modernity in the country for being an entirely planned capital. The project, despite having been fragmented, was innovative for a region where there were not so many investments.

The capital of the state of Goiás, estimated for fifty thousand inhabitants when projected (BARREIRA; DEUS, 2006), surpassed one million inhabitants in 2010, according to the Census of the Brazilian Institute of Geography and Statistics (IBGE, 2010). According to IBGE estimates, in 2020, it believes that the population will be approximately 1,536,097 people.

Since its inception, Goiânia was designed with wide avenues that connect the civic center. Avenidas Araguaia, Pedro Ludovico (now Avenida Goiás) and Tocantins converge in this center (MONTEIRO, 1938). It shows that there was concern in the city's project to create space to house existing cars and others that would come later.

The capital went through an accelerated process of population growth in a short period, causing several problems for its residents, including mobility. It is also part of the Metropolitan Region (RM) of Goiânia, which has 19 other municipalities close to the capital, within these, there are residents who travel to the resident city – Goiânia every day.

Therefore, according to Borges (2015, p. 80):

> Difficulties with mobility increased with the increase in the number of people, arranged in different spaces and aiming at numerous destinations to carry out activities. Goiânia, therefore, in addition to sheltering the displacement of its resident population, also shelters the displacement of the population from the surrounding cities, which causes an exacerbated loss of quality in the capital's urban mobility.

Table 1 shows the average of displacements carried out within Goiânia in 2013, which include collective transport, on foot and individual transport (cars, taxis, motorcycles and bicycles). The first accounts for 30%.

Table 1: Modal distribution in the city of Goiânia in 2013.

Travel Mode	Daily Average of Displacements
On Foot	561,511
Passenger Vehicle Transportation	647,898
Individual transport	950,250
Total	**2,159,660**

Source: Sustainable Cities Program (2014).

As for individual transport, the Goiânia Mayor´s Office in conjunction with the company Serttel and sponsored by Unimed, started in 2016 the implementation of shared bicycle stations. The project has 20 stations and 200 bicycles in total (GYN DE BIKE, 2019). It is a stimulus to develop sustainable mobility in the capital, encouraging residents to use more non-motorized means of transport when traveling.

In 2019, the service of Yellow bikes and Grin and Rappi scooters was implemented by the company Grow. Both were application-driven and credit cards were used for payment. The amount of travel with these means was calculated by distance and there was an initial fee for renting the service. In Goiânia, it operated in a few neighborhoods and ended in January 2020 for operational reasons, according to the company responsible (O HOJE, 2020).

Another way to get around is through individual transport apps like Uber, 99 and others. The first to operate in Goiânia was Uber in 2016, according to a report prepared by the G1 Goiás portal (2016). These apps are private transport services by apps, where the user selects the place of origin, disembarkation, the method of payment and by calculating the distance between them, the value of the run is generated. In addition to the transport apps, there is also the taxi system. There are taxi ranks all over the city and, in addition, it is possible to request the service by calling the centers that operate the system and pass on the necessary information.

As for public transport in Goiânia, it is carried out by bus. In 1976, what is currently called the Metropolitan Network of Collective Transport (RMTC) was created and it was only in the 2000s that it was established in a systemic and integrated way two years after the creation of the RM *(SINDICATO DAS EMPRESAS DE TRANSPORTE URBAN COLETIVO DE URBAN DE PASSENGERS OF GOIÂNIA – SETRANSP, 2013).*

The RMTC consists of 293 lines and buses, with a structure of 21 integration terminals and more than 6,000 stopping points. This transport service provides services for the capital and 17 of the municipalities belonging to the RM of Goiânia (GUIMARÃES et al., 2019, p. 839).

In 2009, as a way of complementing the collective public system, Citybus was created, a more comfortable minibus service at a higher cost than conventional public transport. It was operated on just ten lines with the number of users reduced by the capacity of its vehicles, and it had air conditioning throughout its fleet. The service was discontinued in 2019, and six lines continued to be operated by conventional buses and with a single collective transport tariff of R$4.30 (RMTC, 2019).

As a way to encourage the use of public transport instead of the use of individual motorized transport, *HP Transportes* innovated by creating the new demand-responsive public transport, Citybus 2.0.

Citybus 2.0 aims to be a possible replacement for individual motorized transport, not competing with the public referring to the usual and traditional public transport (Figure 2).

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Figure 2: Citybus 2.0 minibus in Goiânia, GO

Source: RMTC (2020).

Established in February 2019 as an experiment, in less than eight months it became definitive in Goiânia, typified as a differentiated complementary service according to Resolution No. 106, of October 18, 2019 (GOIÂNIA, 2019).

3.2 What is Demand Responsive Transport?

A In order to understand the implementation of Citybus 2.0, it is first necessary to explain what Demand Responsive Transport (DRT) is. According to Häme (2013, p. 9), DRT is: "Often referred to as a form of public transport between bus and taxi services involving flexible routing and scheduling for small and medium vehicles. This means that vehicle routes are updated daily in real-time, incorporating information on transport demand."

DRT transport systems work without fixed schedules and routes in order to provide a flexible collective service according to the travel requests of its users. This is a means of transport that acts as an option for users of individual motor vehicles, as many urban travelers do not consider public transport as an alternative (SIHVOLA; JOKINEN; SULONEN, 2012, p. 75).

For Sihvola, Jokinen and Sulonen (2012), dependence on motor vehicles is also associated with a perception of a low-quality public transport service. DRT is an option because it combines the social, economic and environmental benefits of the bus with the quality obtained with the individual private transport service.

Alonso-González et al. (2018, p. 2, researcher's translation) highlighted 5 aspects of the DRT system, namely: Coverage and routing. Defined by the area of operation and the degree of flexibility in the operation [...]; Hours and functioning [...]Vehicle Features Booking system The system can instantly allow real-time reservations, require advance reservations, or allow both options.

Request for acceptance criteria. Time required to pick up point or vehicle availability are the criteria often used to decide whether an application is accepted or rejected. (ALONSO-GONZÁLEZ et al., 2018, p. 2, my translation).

This type of demand-responsive service was only possible thanks to new technical and technological developments (HÄME, 2013). Since it is a mode: [...] whose transport offer is made through a dynamic urban public transport service for passengers, using smartphone applications or via a service requested by telephone, where users indicate their origin in real-time and destination so that the operator can define the best way to meet this demand. (FURTADO, 2017, p. 5)

Häme (2013) points out that one of the advantages of the DRT over the usual public transport is the fact that it is available when you want and when you want. Narayan et al. (2017) state that this type of transport can solve problems inherent to public transport based on lines and schedules.

Citybus 2.0 initially functioned by installing the 'Citybus 2.0' app on your smartphone. Choosing embarkation and disembarkation, calculation of distance value, vehicle location, vehicle waiting time, place of stop and payment of the trip are all steps performed by the application on the mobile device.

Figure 3 shows the steps necessary to carry out the displacement within Goiânia.

Figure 3: Explanation of how Citybus 2.0 works in Goiânia, GO

(source: prepared by the authors)

3.3 The implementation of Citybus 2.0

Public transport responsive to demand Citybus 2.0 was implemented as of Resolution No. 103, of February 7, 2019. It started as a test phase on February 11, 2019 and in October 2019 it became a definitive mode of transport in the capital.

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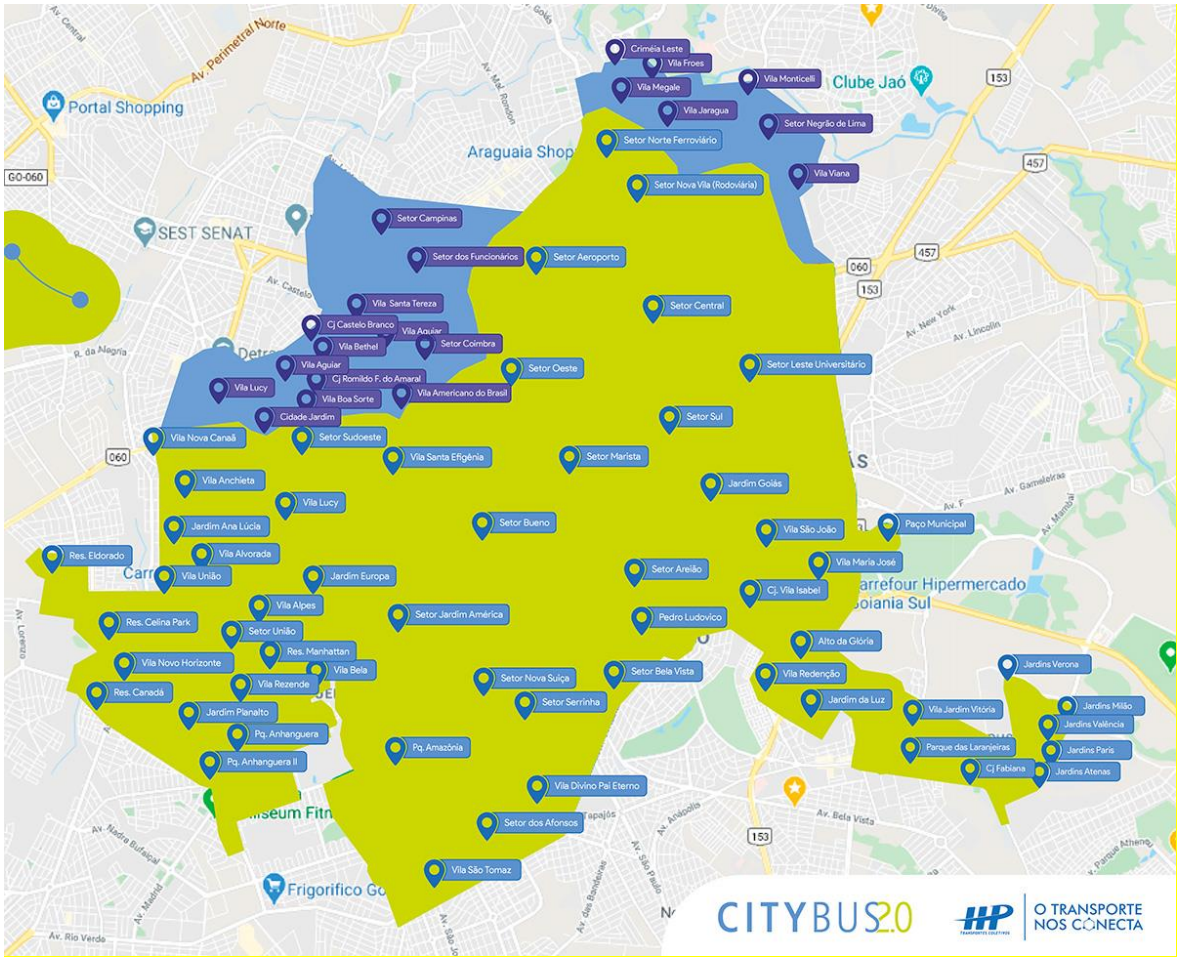
It works through an application that is available both on Android and iOS for mobile devices. Its fleet of vehicles currently comprises 68 minibuses, equipped with comfortable seats for 14 people each, air conditioning, plug-in chargers and USB for cell phones and security cameras (RMTC, 2020).

Citybus 2.0 hours of operation are Monday to Thursday from 6:00 am to 11:00 pm, Friday and Saturday from 6:00 am to 12:30 pm and Sunday from 8:00 am to 10:30 pm. Its service is done through social media and there is an evaluation of the trip at the end of it through the app (RMTC, 2020).

The system works by creating virtual embarkation and disembarkation points so that the average user travels only 130 meters from their location to find or leave the vehicle. The lines are dynamic and the application shows the waiting time for the minibus to arrive at the departure point. The user chooses his departure and arrival point through the application, which calculates the fare according to the distance.

Citybus 2.0 was initially deployed in 11 neighborhoods in the area called *Centro Expandido de Goiânia.* Therefore, over its eighteen months of operation, it has expanded its coverage area, counting in October 2020 with 79 neighborhoods served as shown in Figure 4.

Figure 4: Neighborhoods served by Citybus 2.0 transport in Goiânia, GO



Source: Citybus 2.0 (2021).

According to the RMTC (2020), from implementation in 2019 to February 2020, the application had 80,000 entries and in virtual stores, the 'Citybus 2.0' application received 4.8 stars out of 5.

Regarding the issue of the stipulated tariff for this mode of transport, article 6 of Resolution No. 106, of October 18, 2019, defines:

> Art. 6. The base price of the individual tariff for the CITYBUS 2.0 service is set at 2 (two) times the price of the RMTC basic unit tariff, and the flexible tariff model can be used, variably according to the distance of the trip, with a minimum price R$2.50 (two reais and fifty cents) for the service call (initial flag), to which a freely established price per kilometer will be added, adopting the concept of dynamic tariff according to the market.
> Sole paragraph. Tariff benefits and gratuities, subsidized by cross-subsidies intrinsic to the RMTC tariff, will not be valid on CITYBUS 2.0 service vehicles. (GOIÂNIA CITY HALL, 2019, p. 2)

Due to the guidelines established in Article 12 of State Decree No. 9,653 as of April 19, 2020, all Citybus 2.0 users can only enter the vehicle using masks, the air conditioning remains off and the minibus windows will be open. The vehicle is limited to the number of 6 passengers, respecting social distance (RMTC, 2020).

In 2019, a survey on the quality of the Citybus 2.0 service and the profile of its users by Guimarães et al. (2019), according to 223 interviews with users and non-users, showed that the age group from 18 to 30 years old is the one that most uses this means of transport, numbering 64%. Another important fact that the survey showed was that the main means of transport replacement for Citybus 2.0 was motorized individual transport, with 62% via individual transport apps and 18% via individual cars (figure 5).

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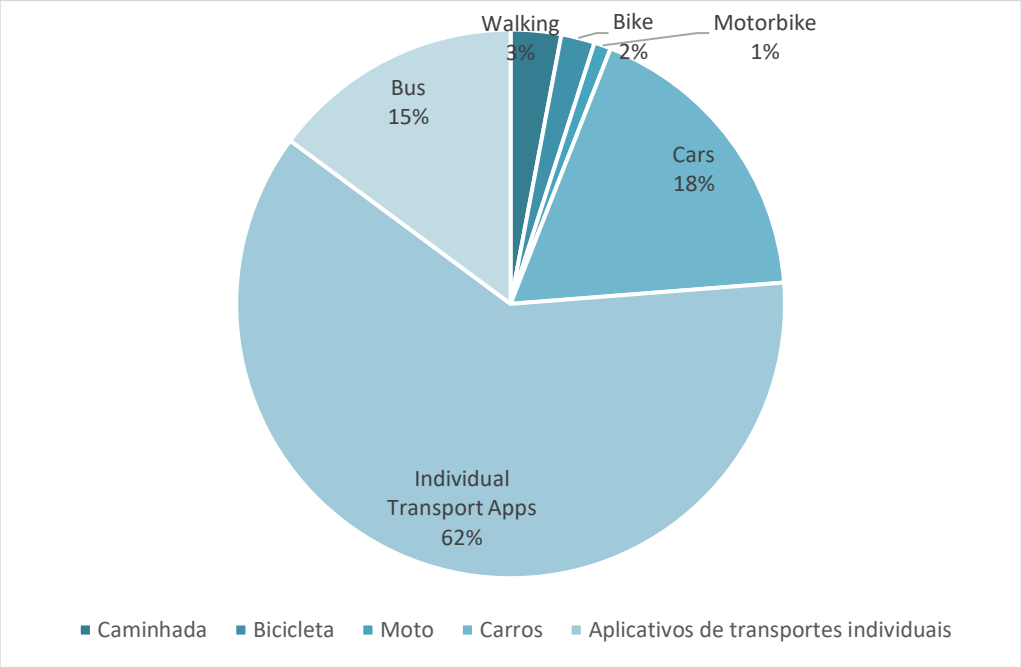
Figure 5: Origin of Citybus 2.0 users in Goiânia, GO.



Source: NTU (2019).

The survey also pointed out that 52% of Citybus 2.0 users have a monthly income of one to five times the minimum wage and that 48% use this means of transport to get to work.

3.4 Citybus 2.0 Satisfaction Survey in Goiânia, GO

The Citybus 2.0 means of transport was something innovative and gained more and more adepts to the service, and consequently increased its fleet and service radius.

It is essential to understand that user satisfaction is important to verify what improvements are needed or what can be changed in order to satisfy those who use the service on a daily basis. According to Mahmoud and Hine (2016), the quality of a public transport service is determined if its provided function matches the expectations of its user.

In order to assess the level of satisfaction of its users, a questionnaire was carried out through an online platform. Since:

> Customers are increasingly informed and have become more demanding, raising the level of need for quality improvement. It appears that organizations are realizing that service quality can be turned into a highly effective weapon for the service organization – a guarantee to meet customer needs and expectations. (LOPES, 2009, p. 17)

Figure 6 shows the segmentation of users and non-users of the Citybus 2.0 service in the capital by the responses to the questionnaire for the sample group evaluated.

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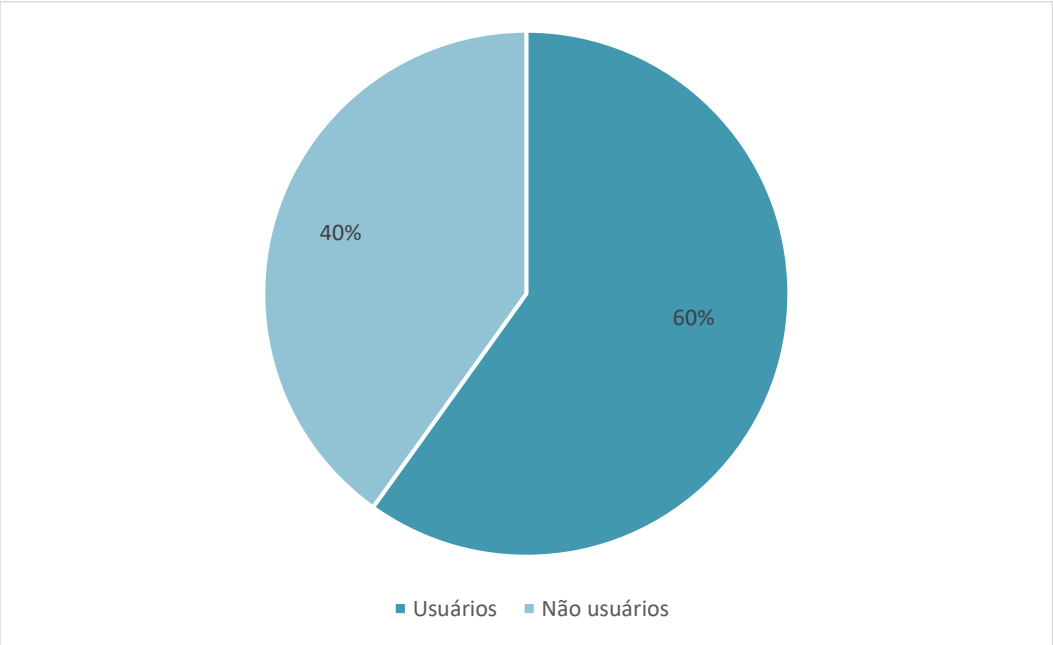
Figure 6 – Citybus 2.0 users and non-users in Goiânia, GO



Source: Prepared by the authors, 2020.

The Questionnaire with ten questions, eight referring to the quality of the service provided by Citybus 2.0, is intended only for users of the means of transport. Table 2 presents the results.

Table 2: Evaluation of the Citybus 2.0 user satisfaction survey, Goiânia, GO.

Questions	**Replies**				
	Great	Good	Regular	Bad	Great
How do you rate this service?	32.31	48.46	4.61	13.85	0.77
As for comfort?	36.92	46.92	10.00	4.62	1.54
Concerning the motorist´s driving?	35.38	48.46	12.31	1.54	2.31
Concerning the fare?	7.69	33.85	37.69	6.15	14.62
As for the system application?	21.54	53.85	16.15	5.38	3.08
As for the virtual stopping point system?	16.92	49.23	24.62	2.31	6.92
Concerning the information on the app?	23.08	51.54	18.46	2.31	4.61
As for the service radius?	10.77	26.92	33.08	0.77	28.46

Source: Prepared by the authors, 2020.

It is noticed that more than 50% of users classify as "good" the information needed in the application and system by application, indicating that this type of transport, being on an online platform, is interesting.

As for comfort, the virtual stop system and the motorist´s driving, they have a good rating since most of their users consider these items “good” or “great”. It was found that the

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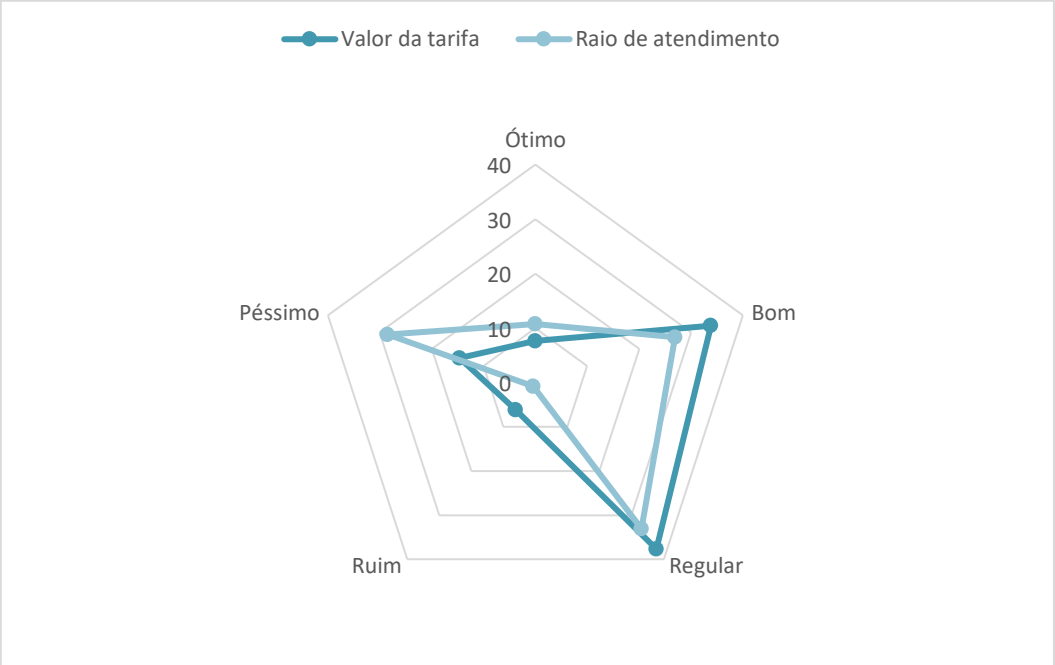
highest percentages for the "Bad" evaluation were in terms of the fee and service radius (Figure 7).

Figure 7: Citybus 2.0, GO tariff and service radius assessment.



Source: Prepared by the authors, 2020.

With regard to the amount of the fare, it is charged according to the distance of the trip, that is, the higher the mileage, the higher the fare. Regarding the service radius, in eighteen months of implementation, the service has already gone through six expansions in its service range.

Citybus began serving 11 neighborhoods and in October 2020 it now serves 79 neighborhoods. The company responsible for the service shows that it is concerned with increasing the service area of the means of transport (RMTC, 2020).

In addition to the questions related to the satisfaction of the means of transport, a question was created in the questionnaire in order to know whether the 217 people who answered this one, whether users of Citybus 2.0 or not, would switch from private motorized transport to use the new demand-responsive collective transport. Figure 8 shows that 24%, that is, 53 people responded that they would replace their means of transport and 77 people (which equates to 36%) replied that they would perhaps replace it.

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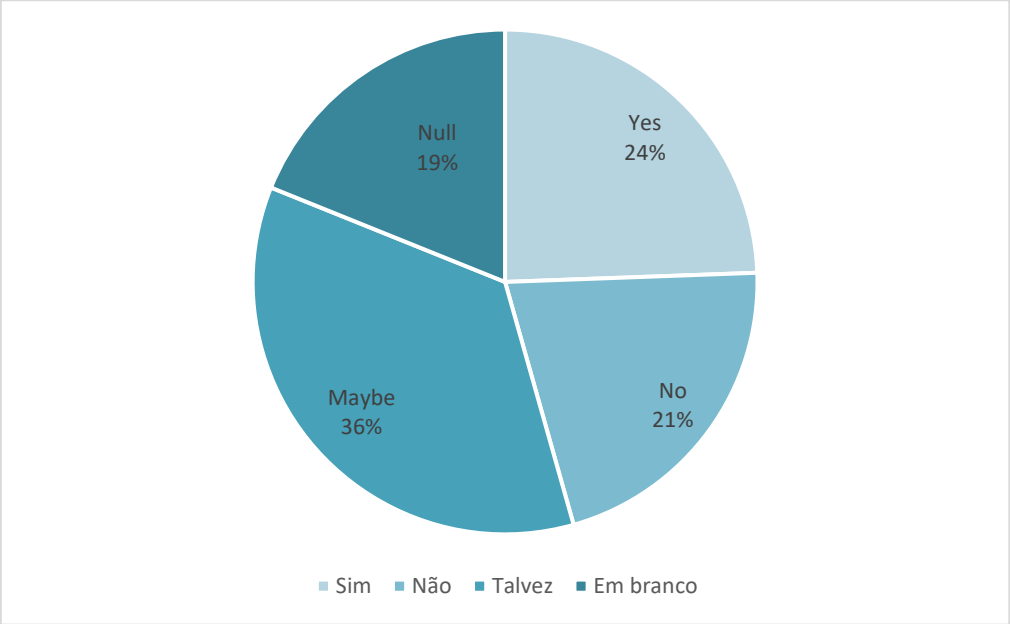
Figure 8: Would you leave private motorized transport to make use of Citybus 2.0 in Goiânia, GO?



Source: Prepared by the authors, 2020.

It is evident that there is a high probability, with the sum of the 36% who answered maybe and with the 24% who answered yes, that the new demand-responsive transport, Citybus 2.0, is a real replacement option for the individual motor vehicle and, consequently, improving traffic in the city, in the pursuit of sustainable urban mobility.

Subsequently, after analyzing all the graphs and tables generated from the Citybus 2.0 survey, Pearson's chi-square test was performed in order to obtain a relationship between the expected number of responses in table 5 and what was observed in the survey. According to Araújo Neto (2014), the test makes it possible, from the comparison of data, to define whether they differ statistically or not. Tables 3 and 4 show the values referring to the number of responses obtained and the expected number.

Table 3 Evaluation of the number of responses obtained in the survey referring to Citybus 2.0, Goiânia, GO

Questions	Great	Good	Regular	Bad	Terrible	Total
How do you rate this service?	42	63	6	18	1	130
As for comfort?	48	61	13	6	2	130
Concerning the motorist´s driving?	46	63	16	2	3	130
Concerning the fare?	10	44	49	8	19	130
As for the system application?	28	70	21	7	4	130
As for the virtual stopping point system?	22	64	32	3	9	130
Concerning the information on the app?	30	67	24	3	6	130
As for the service radius?	14	35	43	1	37	130
Total	**240**	**467**	**204**	**48**	**81**	**1040**

(source: prepared by the authors)

Table 3 Evaluation of the number of responses obtained in the survey referring to Citybus 2.0, Goiânia, GO

Questions	Great	Good	Regular	Bad	Terrible
How do you rate this service?	30	58.4	25.5	6	10.1
As for comfort?	30	58.4	25.5	6	10.1
Concerning the motorist´s driving?	30	58.4	25.5	6	10.1
Concerning the fare?	30	58.4	25.5	6	10.1
As for the system application?	30	58.4	25.5	6	10.1
As for the virtual stopping point system?	30	58.4	25.5	6	10.1
Concerning the information on the app?	30	58.4	25.5	6	10.1
As for the service radius?	30	58.4	25.5	6	10.1

(source: prepared by the authors)

Therefore, applying Pearson's chi-square test, table 8 reaches a total value of 265.98. Considering that the tabled value of the chi-square from 41.34 to 5%, it is concluded that there is a notable difference between the values. Therefore, there is a difference between the value referring to the number of people who answered the questionnaire and the expected value of answers on the Likert scale.

Table 5: Chi-square test of the research referring to Citybus 2.0, Goiânia, GO.

Questions	Great	Good	Regular	Bad	Terrible	Total
How do you rate this service?	4.80	0.37	14.91	24.00	8.22	52.30
As for comfort?	10.80	0.12	6.13	0.00	6.52	23.57
Concerning the motorist´s driving?	8.53	0.37	3.54	2.67	5.01	20.12
Concerning the fare?	13.33	3.54	21.66	0.67	7.78	46.98-
As for the system application?	0.13	2.32	0.79	0.17	3.71	7.11
As for the virtual stopping point system?	2.13	0.54	1.66	1.50	0.13	5.96
Concerning the information on the app?	0.00	1.27	0.09	1.50	1.68	4.54
As for the service radius?	8.53	9.36	12.01	4.17	71.33	105.40
TOTAL						**265.98**

(source: prepared by the authors)

This study then shows that there is an expected number of responses in each of the five options, but that it changes considerably. This is because it depends on the satisfaction of customers who use this type of transport to define the actual evaluation of services. For example, the expected number evaluating very poor in terms of the service radius is 10.125 responses but the figure observed in the survey was 37. The test showed that, statistically speaking, there is a difference between the analyzed values.

4. FINAL CONSIDERATIONS

The capital of Goiás has gone through and is going through several difficulties with regard to mobility. All citizens have the right to come and go, but that does not mean that there are no daily obstacles in the lives of people in cities to exercise this right. A simple commute from home to work can mean hours of traffic jams, bus lines, lack of security, among other problems that are part of everyday life in Brazilian metropolises.

Citybus 2.0 was implemented in Goiânia as a part of the solution. This new means of transport was proposed as a way to remove more private vehicles from the roads in order to improve traffic and several other complications that this type of transport brings to cities. Even though it has only been in operation for a short period, it is noted that it was a positive innovation for urban mobility.

The number of supporters in this period and the number of positive responses in the questionnaire showed that it is a means of public transport that has been gaining more and more users. The comfort, the motorist´s driving, the system per application and the virtual point system were satisfactorily evaluated in the research.

Its operating system is entirely digital and its virtual point system show that technology can be used as a tool in favor of sustainable mobility in cities. As it is a form of transport used by a relatively young public, as shown in the research by Guimarães et al. (2019), the entire travel tracking and management system per application is a positive factor.

The service radius of Citybus 2.0 underwent improvements within the eighteen months of activity, but it was the worst-rated item in the survey. It shows that it is up to the responsible company to further expand the service to meet user satisfaction and also as a way of inviting non-users to use this form of transport.

The item that received the most “Regular” response was the value of the Citybus 2.0 fare. *HP Transportes* has shown concern. According to the RMTC, in September 2020 payment was allowed using *Cartão Fácil,* a card that is used in Goiânia to pay for conventional public transport. In October 2020 there was also the integration of the Citybus 2.0 collective DRT with public transport buses. As an incentive to use both on the same route, the user will earn credits in the value of bus tickets for trips on the Citybus 2.0 app for a period of up to 30 days.

As for the chi-square test, it can be concluded that the research applied to transport users is important, as there is a considerable difference between the expected value of the answers, statistically speaking, and of what was answered through the implemented questionnaire. This result shows that the research is relevant because it is based on this that the quality of Citybus 2.0 services is positively or negatively evaluated through what actually happens on a daily basis, from the users´ point of view.

It was found with the survey that the new means of transport is beneficial for urban mobility, consequently also for the quality of life of the population. Its intention to be a substitute for motorized transport brings improvements to the city and makes it an example of progress towards sustainable mobility. Citybus 2.0 is, therefore, a transport model for other Brazilian metropolises.

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