

Perception of public transport in Brazilian capitals in the COVID-19 pandemic

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ABSTRACT

The COVID-19 pandemic hit the world in 2020. The most prominent measure to deal with the new coronavirus was social isolation. One of the initial recommendations was for people to avoid public transport when possible. This study seeks to analyze whether there was a significant change in the mode of displacement of the population of Brazilian capitals during the COVID-19 pandemic, what is the perception and the main challenges of public transport in this context, and which contagion measures population considers safer. The methodology involved a survey of the measures adopted to combat the spread of the new coronavirus and the application of a public transport perception questionnaire before, during, and after the pandemic. The results show a reduction in modal share of trips made on public transport modes and an increase in the percentage of trips by car; and that public transport systems can be safe and perceived as that, since operators adopt adequate security measures. This is not, however, the perception of those who commuted by public transport during the pandemic. It is important that passengers perceive the system as safe for resumption of demand in the post-pandemic scenario. The key challenge lies in the financing of public transport systems, and it is necessary to analyze a restructuring that will allow to offer a high quality and safe service to the transmission of SARS-CoV-2.

KEYWORDS: COVID-19, Public Transport.

1. INTRODUCTION

The outbreak of the new coronavirus (SARS-CoV-2) pandemic surprised the entire world in 2020. Decreed on March 11, 2020 by the World Health Organization, the pandemic required rapid responses and actions to deal with a virus about which little or no information was available (WHO, 2020). As one of the key measures to cope with the spread of SARS-CoV-2 was social isolation, several sectors faced drastic changes in a brief time, public transport being one of these sectors. The social distancing goes against the concept of public transport, since the vehicles often carry passengers above their capacity, especially during peak hours. One of the initial recommendations was that people should avoid using public transportation when possible and avoid crowded vehicles when not, besides adopting individual protection measures, such as masks and hand sanitizers. For companies, measures to sanitize the vehicles and reduce the number of passengers carried were the main recommendations (DE VOS, 2020; MUSSELWHITE *et al.*, 2020).

Public transport had been losing passengers since before the pandemic, but during the pandemic there was an intensification of this process. The reduction in bus demand reached 80% in March 2020 and in December, even with a partial return of demand because of the flexibilization on social isolation measures, there was still a fall of 39.1% in relation to the typical normal (NTU, 2021). In rail systems, by the end of 2020 the drop was 45.4%, with an estimated loss in the year of about 1.9 billion passengers (ANPTrilhos, 2020). Fear of the disease or government regulation for people to stay at home may have occasioned this reduction in demand (COUTO *et al.*, 2020). Since in most Brazilian cities public transport systems are exclusively funded by fare collection, the pandemic represented a sharp drop in revenue in 2020, estimated at R\$9.5 billion (around \$1,7 billion) for buses and R\$7.3 billion (around \$1,3 billion) for rail systems (ANPTrilhos, 2020; IPEA, 2013; NTU, 2021). Couto *et al.* (2020) state that “at this moment, the need for subsidies for public transport is clear.” The pandemic can serve as a conditioning factor to rethink not only fare subsidy schemes, but an entire restructuring in public transport systems financing.

The use of individual motorized modes, although a safer option in relation to the contamination of the new coronavirus, presents the same problems as before the pandemic,

and cannot be considered a sustainable alternative given all the externalities caused. Besides noise, air pollution, congestion and accidents, car use perpetuates social inequalities because those who do not have access to a private vehicle are often disadvantaged (DAVISON and KNOWLES, 2006). So, it is necessary to provide high quality and safe public transport for the transmission of SARS-CoV-2 and possible new pandemic vectors.

Therefore, it is necessary to study the perception that public transportation had during the pandemic and what are the perspectives and challenges for the post-pandemic, if there was a change in the modal split and if so, if it is a change that has a perspective of being permanent. It is also important to research whether people perceived public transport systems as safe during the pandemic of COVID-19.

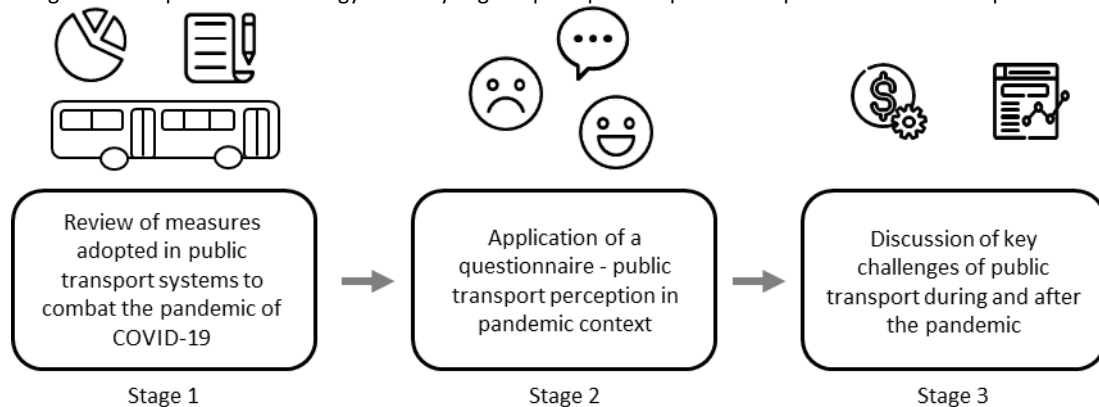
2. OBJECTIVES

This study proposes to analyze whether there was a significant change in the mode of travel of the population of Brazilian capitals during the pandemic of COVID-19, starting from the assumption that people migrated from the public modes to active modes or to travel in individual private vehicles. We seek to understand the behavior of the population, if there is an expectation of return to public transport after the pandemic and which containment measures population consider safer. We also seek to make notes regarding the key challenges faced during the pandemic and that will extend to the post-pandemic period.

3. METHODOLOGY

The methodology of this work has of three stages. The first comprised a review of the measures adopted to face the spread of the new coronavirus in Brazilian capitals. In the second stage, we applied a questionnaire about people’s commuting patterns and perception of public transportation before, during and after the pandemic. From the synthesis of these two stages, in the third we discussed the key challenges faced during the pandemic and that will extend to the post-pandemic. Figure 1 presents a scheme of the methodology used.

Figure 1 – Proposed methodology for analyzing the perception of public transport in the COVID-19 pandemic



Source: Authors, 2021.

We applied the questionnaire on public transport perception online, through social networks in groups from each capital, besides local universities’ e-mail lists. The questionnaire

had three sections: i) socioeconomic data; ii) information on travel patterns before and during the pandemic, besides what measures were adopted to increase safety in relation to contamination in stations and vehicles; iii) expectation of travel patterns in the post-pandemic and perception of safety if certain measures were adopted.

For all participants to start from the same hypothetical situation, the post-pandemic scenario adopted presented in the questionnaire was described as follows: the population receives one of the available vaccines against the new coronavirus and the incidence of COVID-19 decreases, but it is still necessary to adopt sanitary measures such as the mandatory use of masks, social distancing to contain crowds and constant sanitization.

Sample size was calculated using Eq. (1) and Eq. (2), a methodology also used by Antunes and Simões (2013) and Barcelos *et al.* (2017). The parameters used were confidence level of 95% and tolerable sampling error of 5%, being necessary 400 responses.

$$n_0 = \frac{1}{E_0^2} \quad (1)$$

$$n = \frac{N * n_0}{N + n_0} \quad (2)$$

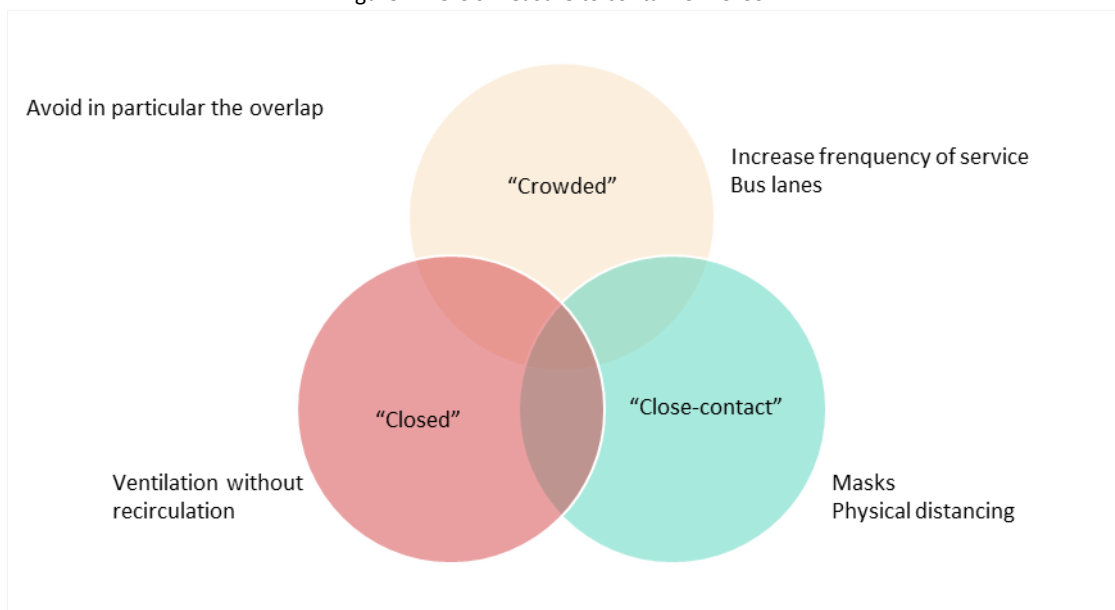
Where n_0 is the first approximation of the sample size; E_0 is the tolerable sampling error; n is the sample size and N is the population size.

4. RESULTS

4.1 Review of measures adopted in public transport systems to contain the pandemic of COVID-19

The emergency of the pandemic caused a response to the operation of transport services worldwide. In several Brazilian cities, there was demand and fleet reduction (NTU, 2021). However, despite the need to adapt to the pandemic, it is clear the importance of public transport to ensure access and continuity of basic services and even to combat the COVID-19 (UITP, 2020). Several agencies claim that, if adopted health safety measures, these systems are safe (ARDILA-GOMEZ, 2020; UITP, 2020). One recommendation made by the Ministry of Health, Labour and Welfare of Japan is to avoid crowded or closed places and close contact with people, in a strategy called 3 Cs (crowded, closed and close-contact), presented in Figure 2 (JAPAN, 2020).

Figure 2 – 3 C's measure to contain SARS-CoV-2



Source: Adapted from Ministry of Health, Labor, and Welfare, Japan (2020) and Ardila-Gomez (2020).

In this sense, Ardila-Gomez (2020) points out solutions such as ventilation without air recirculation, increased frequency of services, implementation of priority infrastructure such as exclusive lanes, and adoption of individual measures such as social distancing and mandatory use of masks. The adoption of combined measures provides greater safety from SARS-CoV-2 contamination, but the measures are not only related to the transport systems themselves. Indirect measures such as staggering the opening hours of shops and services can contribute to spread out the demand for public transport, reducing crowding in vehicles and stations. Among the direct safety measures, it is worth to mention the adequate ventilation of vehicles and stations, monitoring the use of masks and hygiene guidelines, guidelines to avoid conversations and phone calls, monitoring of contamination in the population and among public transportation employees, besides providing faster trips by dedicated lanes (WRI, 2020).

In the Brazilian reality, the National Association of Urban Transport Companies (NTU, 2021) points out that the most used measures in public transport systems by buses were nebulization disinfection, end of cash for fare payment, social distance signaling, limitation of number of passengers, tunnels for body disinfection and body temperature measurements. According to National Association of Passenger Railway Carriers (ANPTrilhos, 2020), in rail systems there was cleaning of stations, trains and contact areas, adoption of sanitization technologies, such as spraying of disinfectant products and use of ultraviolet light, temperature measurement through cameras, passenger orientation campaigns, installation of specific visual communication to indicate distance, maintenance of the supply of trains at levels well above demand, training of employees to serve the public in the face of the pandemic, home office work for non-operational areas and risk groups and availability of hand sanitizers and personal protective equipment for the teams.

4.2 Questionnaire on the perception of public transport in the pandemic context

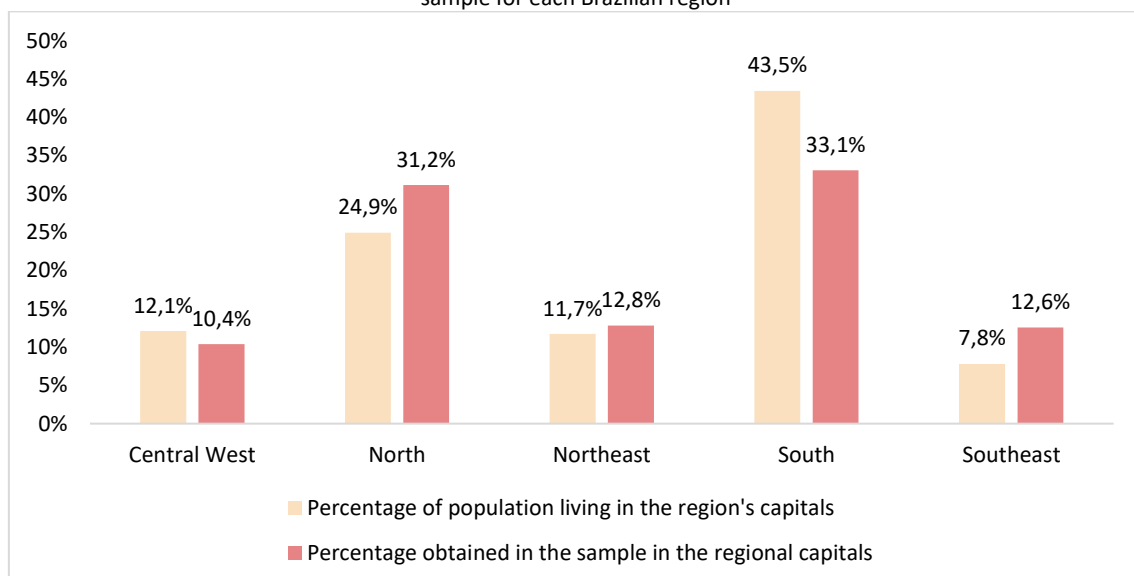
The questionnaire was available online from January 18 to February 15, 2021, and we collected 414 responses. In the following topics, we characterize the sample and discuss the results.

4.2.1. Sample Characterization

The cities with the highest number of answers were São Paulo - SP (81), Recife - PE (48), Rio de Janeiro - RJ (36) and Maceió - AL (24). No answers were obtained in the cities of Boa Vista - RR and Cuiabá - MT. Figure 3 presents the proportion of the population living in the capitals of each Brazilian region (first column) and compared with the distribution of the answers obtained in the capitals of each region (second column). The sum of the first column corresponds to the total resident population in Brazilian capitals.

Regarding the socioeconomic data of the sample, it is divided as follows: i) gender: 62.8% are female, 36.5% are male and 0.7% preferred not to answer; ii) age: 4.6% were under 20 years old, 46.9% were between 21 and 30 years old, 26.3% were between 31 and 40 years old, 11.1% were between 41 and 50 years old, 8% were between 51 and 60 years old and 3.1% were over 60 years old; iii) ethnicity: 1% declared themselves yellow (Geographic family origin: Japanese, Chinese, Korean, etc.), 57.5% white, 0.7% indigenous, 10.1% black, 27.3% pardo (brown), 2.4% preferred not to answer and 1% declared another ethnic group; iv) occupation: 31.9% declared themselves students, 18.6% CLT workers, 13.5% self-employed, 2.2% informal workers, 24.9% public employees, 1.2% retired, 5.1% unemployed and 2.7% declared they had another occupation.

Figure 3 - Regional proportion of population living in capital cities and the percentage of responses obtained in the sample for each Brazilian region



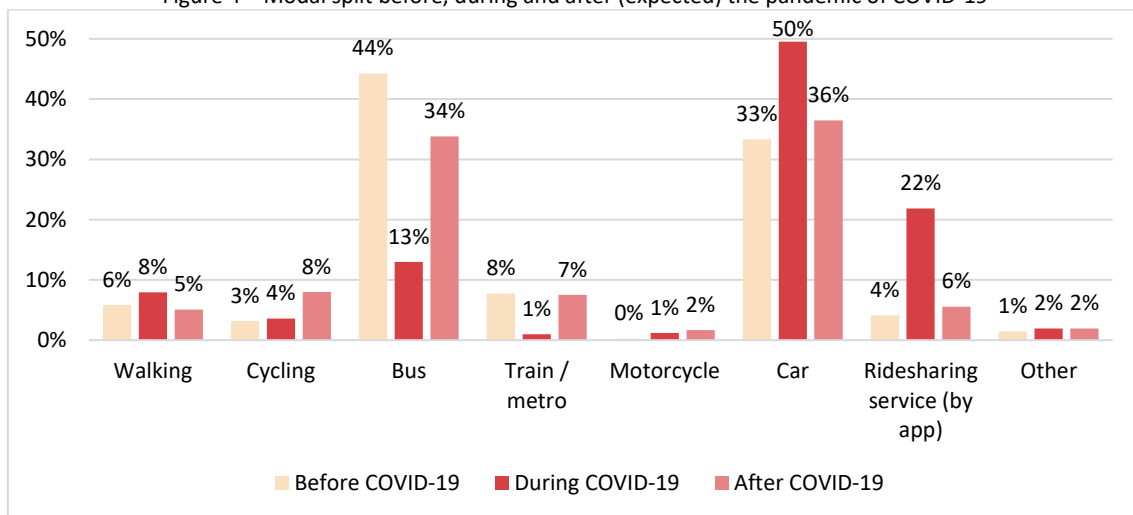
Source: Authors, 2021.

4.2.2.Modal split

Three questions were presented in relation to mode choice, in brief “How did you usually commute before the COVID-19 pandemic?”, “How did you usually commute during the COVID-19 pandemic?” and “How do you intend to commute after the COVID-19 pandemic?”. In the case of more than one mode, participants were instructed to select the primary mode, i.e., the one with the longest travel time. The results show that public transport, either by bus or by train/metro, lost modal share during the pandemic. Part of the participants intend to use such modes again after the pandemic. However, according to the answers, the participation of public transport will be lower than before the pandemic. The mode on foot showed an increase in the pandemic, but the percentage afterwards is lower than before the pandemic. The bicycle mode remained constant during the pandemic, but is expected to increase after the pandemic. Worrying results are found in individual motorized modes. The motorbike, car and ridesharing services modes increased their modal shares, with the highlight being the significant increase in car from 33% before the pandemic to 50% during and 36% after the pandemic. The results can be visualized in Figure 4.

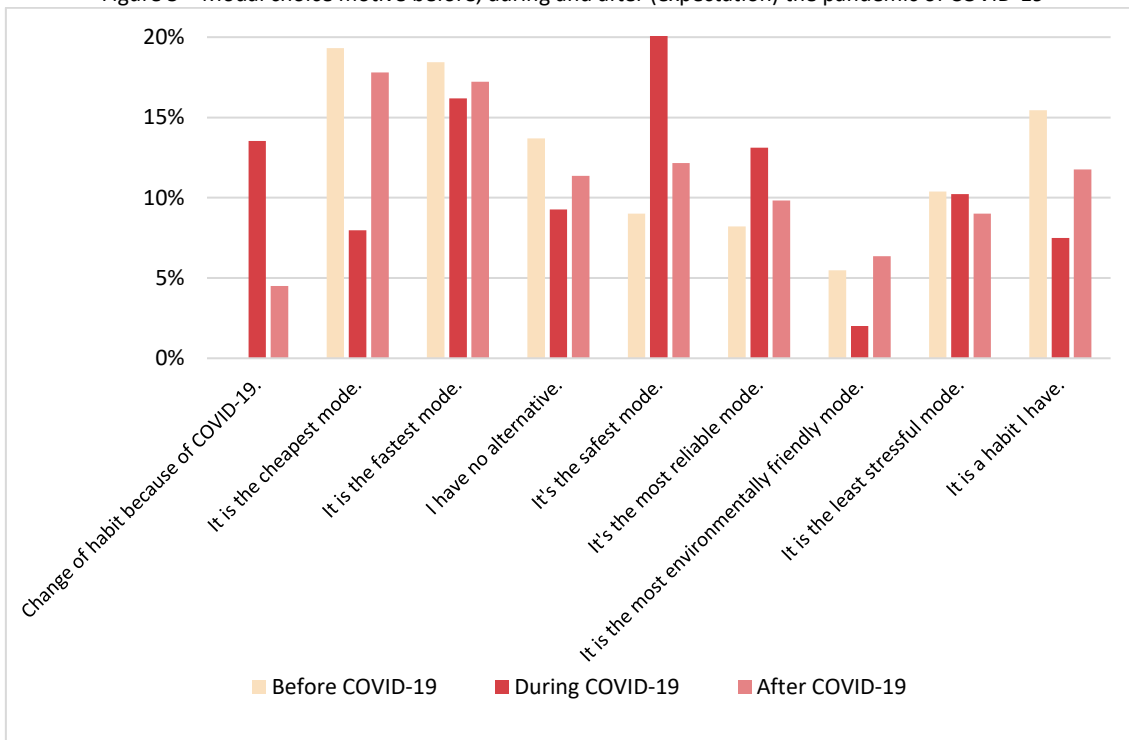
The participants were asked about the reason for choosing the primary mode. A list was presented and they should select three reasons for each scenario (before, during and after the pandemic). Figure 5 shows the results obtained and it can be seen that during the pandemic, the reasons “It is the cheapest mode.”, “It is the fastest mode.”, “I have no other alternative.”, “It is the most environmentally friendly mode.”, “It is a habit that I have.” showed a drop, while the reasons “Habit change because of COVID-19.”, “It is the safest.” and “It is the most reliable.” increased considerably in the during and post-pandemic scenarios. The reason “It is the least stressful way.” showed slight variations when compared to the others.

Figure 4 – Modal split before, during and after (expected) the pandemic of COVID-19



Source: Authors, 2021.

Figure 5 – Modal choice motive before, during and after (expectation) the pandemic of COVID-19



Source: Authors, 2021.

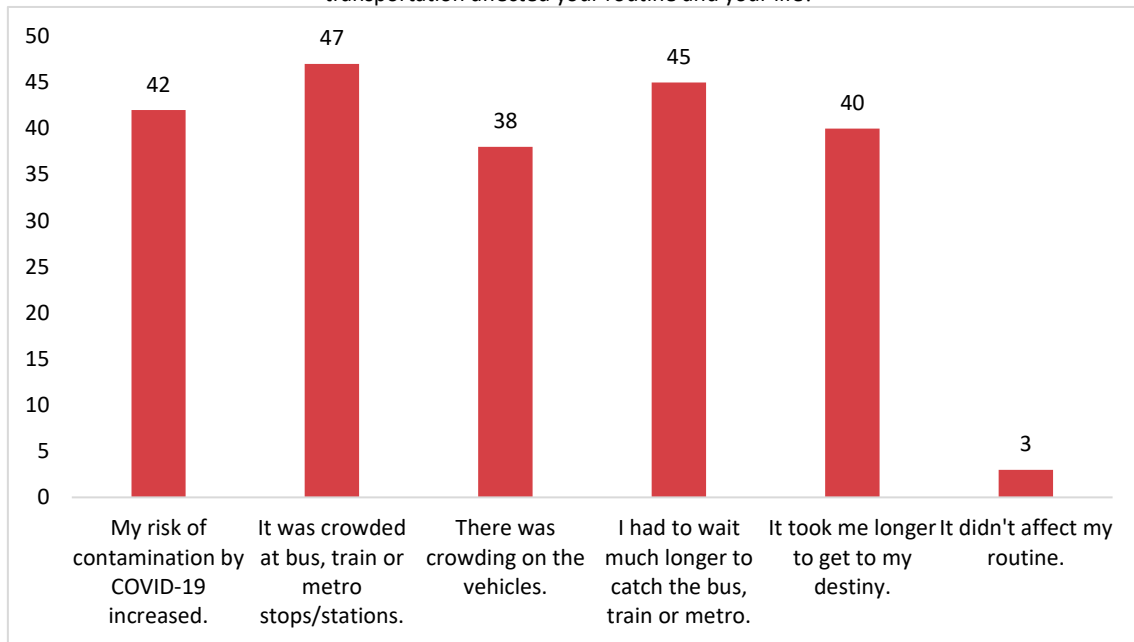
From the results, we can conclude that there was a tradeoff during the pandemic and people chose the modes for reasons related to safety and reliability, to the detriment of reasons related to cost, speed of travel and previously maintained habits. Also, about 14% of the participants stated that one reason for mode choice during the pandemic was a change of habit because of COVID-19. In the post-pandemic period, 4.5% of the participants selected this reason.

4.2.3. Perception of public transportation during the pandemic

Participants who affirmed that they commuted by public transportation during the pandemic were directed to an additional part of the questionnaire. In total, 58 participants answered this part, which represents around 14% of the total sample.

Figure 6 presents the frequency of responses for the question “How has the reduction of the timetable, change in lines or fleet of public transportation affected your routine and your life? Select all options that you identify with.” Only three participants stated that the changes did not affect their routine. Other factors included feeling an increased risk of contamination by COVID-19, crowding at bus, train, or subway stations and inside vehicles, and increased waiting and commuting times. The question also had an “Other” option where participants could add difficulties they had encountered that were not on the provided list. In this option, there was only one answer from a participant from Salvador - BA, who said “My line was arriving every 2 hours, I had to take lines from other neighborhoods and walk”.

Figure 6 – Responses from the question “How has the reduction of the timetable, change of lines or fleet of public transportation affected your routine and your life?”

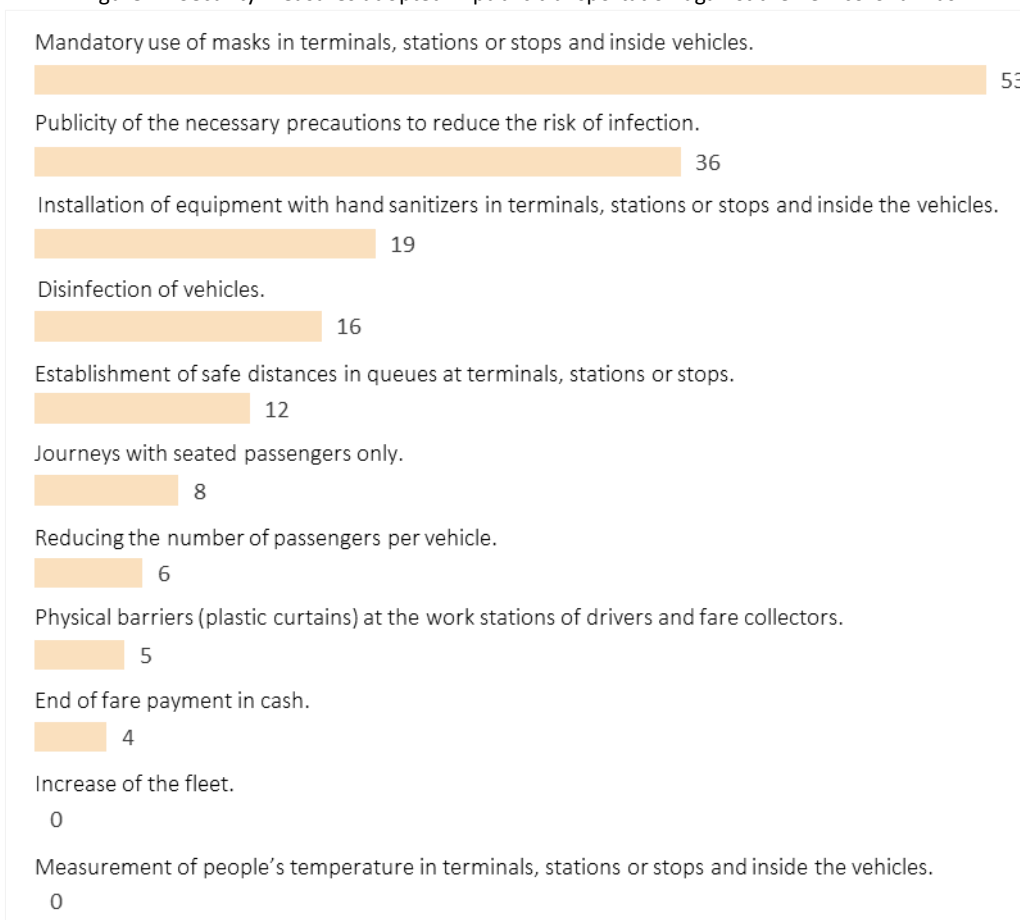


Source: Authors, 2021.

Another question in this additional part was “What safety measures against the new coronavirus have been adopted in public transportation in your city? Select all options adopted.” This question, whose results are in

Figure 7, intended to list the measures addressed in the item 4.1 and analyze which ones were in fact implemented in Brazilian capitals. Among the measures selected by the participants, the most frequent were “Mandatory use of masks in terminals, stations or stops and inside the vehicles”, “Publicity of necessary precautions to reduce the risk of infection”, “Installation of equipment with hand sanitizers in terminals, stations or stops and inside the vehicles”, “Disinfection of vehicles” and “Signaling of safe distance in lines in terminals, stations or stops”. Of the 58 responses, statements related to the reduction of passengers transported by vehicles were selected less than 10 times, while no participant stated that there was an increase in the fleet. In the “Other” option, a participant from Recife-PE stated “There was no intervention along these lines. On the contrary, there was fleet reduction and overcrowding. The recommendations were clichés, individual self-care was the possible alternative.”.

Figure 7 - Security measures adopted in public transportation against the new coronavirus



Source: Authors, 2021.

Table 1 presents the perception, using a Likert scale, of public transportation during the pandemic of the new coronavirus. The questions present a high percentage of negative answers, with 77.6% of the participants of this part stating that they find the measures adopted totally insufficient or insufficient, 60.3% think that the measures taken by the companies were not complied with or were complied unsatisfactorily. In terms of monitoring, 81.0% answered that there were none or insufficient, and 89.7% felt not safe at all or not very safe when using public transportation during the pandemic. The lowest negative percentages were in relation to the publicity of the measures adopted and the compliance with individual protection measures, where 34.5% pointed out that there was no publicity or it was insufficient, and 48.3% said that the individual measures were not complied with or were insufficiently complied with. The low percentage of positive answers shows that the perception of users conflicts with the recommendations presented in item 4.1.

Table 1 - Perception of public transportation during the new coronavirus epidemic

Measures	Perception				
	Totally insufficient	Insufficient	Indifferent	Partially sufficient	Fully sufficient
Do you think that the measures adopted are sufficient to contain the spread of SARS-CoV-2?	41,4%	36,2%	15,5%	5,2%	1,7%
	No divulgation	Insufficient divulgation	Indifferent	Good divulgation	Excellent divulgation
Have the measures adopted been widely publicized?	6,9%	27,6%	37,9%	19,0%	8,6%
	Unfulfilled	Fulfilled precariously	Indifferent	Partially fulfilled	Fully fulfilled
Do you think that the individual measures have been complied with by other users of public transport? For example, wearing a mask is compulsory.	24,1%	24,1%	22,4%	15,5%	13,8%
Do you think that the measures of the public transport companies have been complied with? For example: disinfection of vehicles.	25,9%	34,5%	27,6%	8,6%	3,4%
	No inspection	Insufficient inspection	Indifferent	Good inspection	Excellent inspection
Were the safety measures adopted monitored? For example, if users were wearing masks or if the vehicle was overcrowded.	50,0%	31,0%	13,8%	5,2%	0,0%
	Not at all safe	Unsafe	Indifferent	Safe	Very safe
Did you feel safe using public transport during the COVID-19 pandemic?	60,3%	29,3%	6,9%	3,4%	0,0%

Source: Authors, 2021.

4.2.4. Safety perception regarding post-pandemic measures

Finally, the question “How safe would you feel if the following measures were adopted in your city’s public transportation after the COVID-19 pandemic?” was asked to all survey participants. The responses are in Table 2. We can highlight that, for monitoring of the safety measures adopted, 84.5% of the participants stated they would feel safe or very safe; for the reduction in the number of passengers carried and the disinfection of vehicles, 83.1% and 81.9%, respectively, would feel safe or very safe. The large percentage of positive responses suggests that there is a possibility of conveying safety in public transport systems if adopted necessary safety measures.

Table 2 - Safety perception regarding the spread of the new coronavirus if each measure was implemented

Measures	Safety Level				
	Not at all safe	Unsafe	Indifferent	Safe	Very safe
Mandatory use of masks in terminals, stations or stops, and inside vehicles.	5,1%	6,0%	22,9%	33,1%	32,9%
Installation of hand sanitizers in terminals, stations or stops and inside the vehicles.	5,3%	6,8%	21,5%	31,2%	35,3%
Reduction in the number of passengers carried per vehicle.	3,1%	2,9%	10,9%	31,6%	51,4%
End of fare payment in cash.	7,7%	11,8%	27,8%	22,5%	30,2%
Disinfection of vehicles.	2,9%	3,4%	11,8%	27,8%	54,1%
Publicity of the security measures adopted.	5,3%	7,0%	19,3%	27,8%	40,6%
Monitoring the safety measures adopted. For example, if users were wearing masks or if the vehicle was overcrowded.	3,1%	5,1%	7,2%	22,9%	61,6%

Source: Authors, 2021.

4.3 Challenges for public transportation during and after the pandemic

As presented in section 4.2.3, public transportation was not safe for those who commuted by it during the pandemic, not only by the perception of crowding in stations and vehicles but also by the increase in waiting and travel times. In Table 1, it was possible to observe that 89.7% of the participants of this study who used public transportation stated that they felt not safe at all or not very safe when using these modes of transportation during the pandemic. The recovery of the image of public transportation is, therefore, one of the key challenges during and after the pandemic. The results in section 4.2.4 reveal that if certain measures were actually implemented, the participants would feel safe about the spread of the new coronavirus.

De Vos (2020) points out that the key challenge in this issue is financing the measures, since they increase operating costs and the reduction in demand because of the pandemic has reduced companies' revenues. Musselwhite *et al.* (2020) state that one must also think about whether frequent cleaning and sanitizing by staff is sustainable over time, as it requires a lot of human resources and its logistics can be complicated. Couto *et al.* (2020) state that "at this point, the need for public transportation subsidies is clear."

According to National Association of Public Transport (ANTP, 2020), "we must recognize that we live a historical mismatch between the demand for quality transportation and the maintenance of its financing model. The pandemic scenario accentuated such contradiction, but it has to be eliminated now and for the future." Among the measures proposed by the organization are: i) the allocation of extra fare resources coming from the public authorities during the pandemic and during the post-pandemic transition phase to a situation of greater normality, so that it is possible to offer the services according to the appropriate safety levels; ii) the implementation of public transportation infrastructure in order to guarantee priority in the circulation of buses on the roads; iii) change of the financing model; iv) change of the contracting model for services provision, contracting supply in order to guarantee the quality standards permanently.

Still, among other measures, is the creation of national funds to finance urban mobility or national regulations for the creation of municipal funds, with an indirect collection of the cost of public transportation through taxes on fuel, on land use or on the production, marketing and

ownership of individual vehicles (IPEA, 2013; IPEA, 2016). It is clear, however, the need for a financial restructuring of public transport systems to ensure the quality of services and the security at this time of health crisis.

5. CONCLUSION

The pandemic caused by the new coronavirus, SARS-CoV-2, has changed the way commuting happens in Brazilian cities. Because of the need for isolation and social distancing, and also because of the fear of COVID-19, public transportation lost a significant percentage of passenger demand. During the pandemic, travel by individual car, whether owned or by ridesharing services, increased significantly. Although there is an expectation of a return to public transport modes in the post-pandemic, modal split percentages were below those found in the period before the pandemic. For cars, despite a reduction in the post-pandemic, they will still be higher than before.

Public transportation can be a safe place, as stated by companies and agencies related to operators, since adopted safety measures to contain the spread of the new coronavirus. In fact, the participants of this research reported significant percentages of safety perception if measures were implemented, such as mandatory use of masks in terminals, stations or stops and inside the vehicles, installation of equipment with hand sanitizers in terminals, stations or stops and inside vehicles, reduction of the number of passengers carried per vehicle, disinfection of vehicles, publicity and monitoring of safety measures adopted. However, the perception of those who commuted by public transportation during the pandemic is not this. The participants of this part of the questionnaire reported high percentages of negative aspects regarding the measures adopted, the compliance of individual and company measures, and the monitoring of the measures; it was possible to observe that 89.7% of the participants of this study who used public transportation during the pandemic stated they felt not safe at all or not very safe when using these modes of transportation. It is important that, besides stating that safety measures are being taken, this should be perceptible to the passengers.

High quality and safe public transport against the transmission of the new coronavirus remains the best alternative to mitigate the externalities of car use, including to curb an increase in the number of trips by individual motorized modes in the post-pandemic period. Future studies are needed on financing alternatives, which do not necessarily link the quality of public transportation to the existence of high demands. Also, alternative sources of revenue need to be considered due to increased operating costs, especially frequent cleaning and sanitizing of vehicles because of the pandemic of COVID-19.

It is noteworthy that the post-pandemic scenario presented for the participants of this paper considers the possibility of vaccination and with it a decrease in the incidence of COVID-19, besides the maintenance of sanitary measures such as the mandatory use of masks, social distance to contain crowds and constant hygiene. The results obtained are therefore related to these conditions.

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