Periódico Eletrônico
Fórum Ambiental da Alta Paulista
ISSN 1980-0827 – Volume 17, número 4, 2021

Implementation of temporary bike lanes as support tools for mobility in Bogotá, Colombia, during the COVID-19 emergency

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Fórum Ambiental da Alta Paulista
ISSN 1980-0827 – Volume 17, número 4, 2021

ABSTRACT

The COVID-19 pandemic presents itself as the greatest health challenge of the 21st century. Among the key measures to contain the spread of SARS-CoV-2 is social isolation, which has affected the processes related to urban mobility. With the need to reduce passengers on public transport and to curb an increase in car trips, several cities have sought to encourage the use of bicycles. This study analyzes the implementation of temporary bike lanes in Bogotá, Colombia, as a measure to confront the COVID-19 pandemic, the changes derived from this measure, and carries out a perception survey on the implementation of this infrastructure. The results show the implementation of 74 kilometers of temporary bike lanes, of which some of them have already been transformed into permanent; the survey shows an increase in the modal participation of the bicycle and that there is an acceptance of the transformation of the infrastructure from temporary to permanent character. However, participants evaluated safety and infrastructure quality criteria negatively. The city's solutions, although capable of improvement, contribute to other cities implementing cycling infrastructure in the pandemic scenario and work to ensure a modal transition in the post-pandemic period.

KEYWORDS: Active transport. Bicycle. COVID-19. Temporary bike lanes.

1. INTRODUCTION

The World Health Organization (WHO) declared in March 2020 the pandemic of COVID-19 caused by the new coronavirus (SARS-CoV-2) (WHO, 2020). One of the key measures to contain the spread of the disease was the adoption of social isolation in several countries, and changes were observed in various sectors of society. Urban mobility was one of them and studies point out that in the pandemic scenario there are positive trends regarding the popularity of bicycle use, but there is also a concern of the declining participation of public transport and the replacement by individual motorized modes (BUCSKY, 2020). While public transportation systems may represent a high risk of contamination, as vehicles often carry passengers beyond their capacity, they are still necessary to transport essential service workers, as well as workers who are fighting the pandemic itself, such as doctors and nurses. Studies point out cycling as a way to reduce the density of public transport, emphasizing the need to invest in infrastructure for bike lanes (BARBAROSSA, 2020; BARRIENTOS-GUTIÉRREZ *et al*., 2020).

The construction of bike lanes in Bogotá began around 1998, due to the changes that occurred in the city because of the BRT TransMilenio implementation. It was decided that these lanes would be built close to the BRT corridors and over pedestrian sidewalks. Later, bike lanes were built near rivers and wetlands, the latter being ecological systems that regulate temperature and water levels during the rainy season within the city. Today, bike lanes are installed on the roadbed, have vertical and horizontal signposts, and are segregated by road studs. The current infrastructure is composed of these two types of implementations, the older ones on sidewalks and the more current ones on the roadbed, segregated from vehicle circulation (LOBO-GUERRERO, 1994).

With the problem of COVID-19 the Bicycle Management, along with other institutions of the Bogotá Municipality, encouraged the use of bicycles by implementing temporary segments of bike lanes, a measure also adopted by other cities such as New York, Philadelphia, London, Mexico City, Buenos Aires, Curitiba, and Belo Horizonte (BAHAMON, 2020; RIBEIRO AND CORRÊA, 2020). The strategy adopted by the city comprises: i) an alternative and temporary network of bike lanes, designed on the roadbeds; ii) development of partnerships with bike sharing systems (MUVO); and, iii) transition from temporary to permanent infrastructure. 74 kilometers of temporary bike lanes were implemented in Bogotá, and part of them have already become permanent. The implementation was developed in 4 phases, considering the segments that were previously established in the mobility plan and factors as the impact on public transport speed and connectivity with permanent cycling corridors (BAHAMON, 2020).

Guzmán *et al*. (2020) point out changes in Bogotá's mobility patterns in a study where about 20% of respondents changed modes during the pandemic. The study divided respondents by income, with those with high incomes seeming more likely to maintain their modal choice, with only 4% of them reporting changes in mode of transport, with a decrease in trips from public transport to walking and a maintenance of trips in private vehicles. Meanwhile, middle-income individuals reported a greater modal shift (20%), with public transport modes decreasing their share in this segment, favoring the use of private or low-occupancy public modes such as walking, taxi, and ridesourcing. Finally, low-income users seem to have fewer transportation alternatives available, and although the changes in this group were the most important within all income groups (26%), most of them show a decrease in car trips to greater use of public transportation.

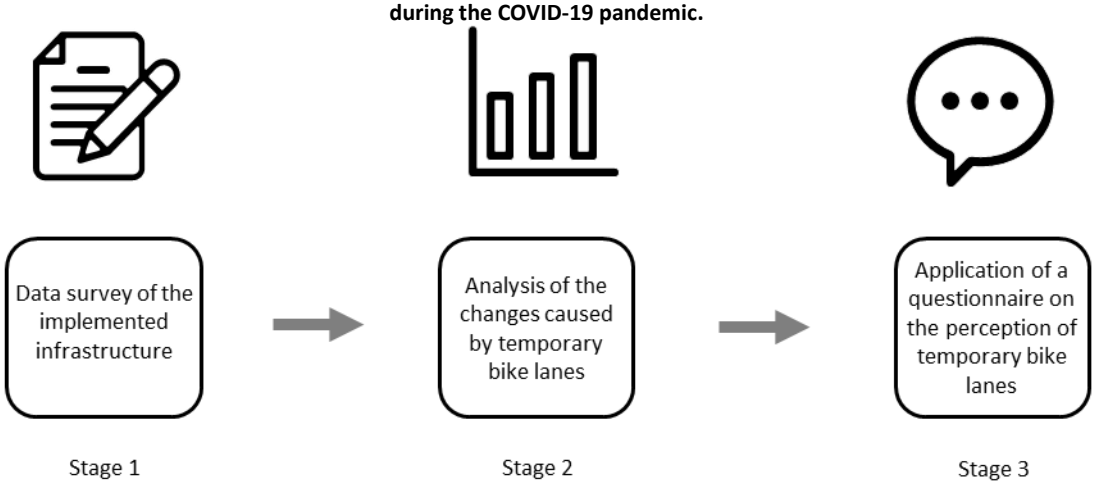
2. OBJECTIVES

The aim of this paper is analyzing the implementation of temporary bike lanes in Bogotá, Colombia, as a measure to confront the pandemic of COVID-19, the changes derived from this measure, and to conduct a perception survey about implementing this infrastructure.

3. METHODOLOGY

The methodology of this paper is composed of three stages. The first comprises a survey of the infrastructure of temporary bike lanes implemented in Bogotá, Colombia, to face the pandemic of COVID-19 and the method used to do so. The second comprises an analysis of the changes caused by implementing the temporary bike lanes, and the third consists of a perception survey regarding the measures adopted. A scheme of the methodology is presented in Figure 1.

Figure 1 - Proposed methodology for analyzing the temporary bike lanes implemented in Bogotá, Colombia, during the COVID-19 pandemic.



Source: Created by the authors, 2021.

The data research on cycling infrastructure and the methodology of the city government to create new temporary bike lanes was conducted on the website of the Secretariat of Mobility of Bogotá, the webinar "Tactical urbanism for Covid-19" and also on the website of the Urban Development Institute (IDU), an institution belonging to the city

government of Bogotá. The bicycle flow data and the changes caused by the temporary bike lanes (Stage 2) was also taken from the webinar cited above (BAHAMON, 2020; MOBILITY SECRETARIAT, 2020a; IDU, 2018)

The stage of perception of city residents regarding the temporary bike lanes was carried out through an online questionnaire, publicized through social networks and messaging apps, being collected socioeconomic data, information about commuting before, during and after the pandemic (expectation) and perception of the temporary bike lanes. The sample size was calculated from Eq. (1) and Eq. (2), as presented by Antunes and Simões (2013) and Barcelos *et al.* (2017). The confidence level is 95% and the maximum tolerable error was 10% due to the difficulty of data collection because of the pandemic itself, thus requiring 100 responses.

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

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

Where:

n_0: first approximation of sample size
E_0: maximum tolerable error
n: sample size
N: population size

4. RESULTS

4.1. Implementation phases of temporary bike lanes

The method used by the Bogotá municipality has four phases. In phases 1 to 3, tests were performed with temporary segments to decide which ones would become permanent in phase 4. Phase 1 started the implementation of temporary bike lanes in segments that were already established in the mobility plan, and later in new segments that allowed direct connections with the existing bike lane network, thus improving safety conditions and comfort for users. In phases 2 and 3, performance measurements were carried out and the most relevant criteria were defined for the selection of the segments that became permanent, in summary: i) performance of the segment in relation to the flow of bicycle users; ii) interference in the flow of public transport; iii) condition of the sidewalk; iv) performance concerning temporary segregation elements; and, v) performance of the other urban mobility actors. From the evaluation of the above criteria, some segments were changed or eliminated. In phase 4, the bike lanes sections that had better evaluations in the test phases became permanent. Figure 2 presents the method adopted by the municipality with its phases, which are described in more detail Table 1. The method adopted by the city government to implement the bike lanes also considered experiences that existed prior to the pandemic, such as the "Car Free Day", an annual event with restriction of circulation of private vehicles, and the "Bike Lane leisure" that operates on weekends in the city.

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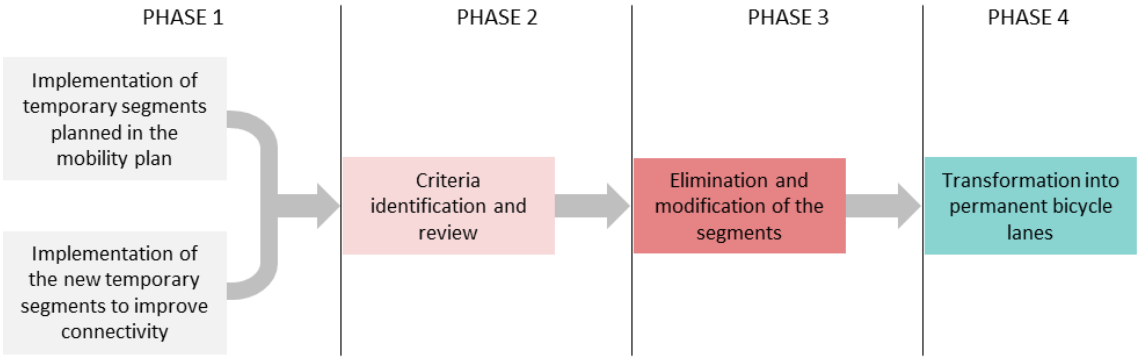
Figure 2 - Methodological diagram for bike lanes implementation in Bogotá.



Source: adapted from BAHAMON, 2020.

Table 1 - Implementation phases of the temporary bike lanes in Bogotá.

Phase	Length	Date	Observations
1	22 km	16/03	The Bicycle Management and Mobility Secretariat led the project, along with other institutions such as the Leisure and Sports Institute, the TransMilenio Transportation System, the Police, and the Risk Management Institute. In Phase 1, connections were established between the eastern and western sectors of the city and the center, that concentrates economic, education, and health services. Here one can highlight corridors such as Carrera 7 and 68th Avenue, which already had within the mobility plan cycling infrastructures planned to be built associated with BRT projects. In other streets, such as Carrera 9, the implementation was completely new, as there were no projects to build cycling infrastructure in this location. However, this segment allowed an interconnection that did not exist before the pandemic and was therefore selected. It is worth mentioning that at the beginning of the process, there was a restriction on private vehicles circulation, so that only those transporting workers who performed activities that could not be performed at home, health workers, police officers, or people who needed priority health care could circulate. This measure had, as a result, a drop in vehicle flows. Measurements of the flow of bicycle users were initiated, and an increase was observed in relation to a typical day, as well as a favorable environment by the population for the implemented measure.
2	117 km	17/03 (morning)	From the results, it was installed temporary bike lanes in all segments that worked on the "car-free day" that is held in the city. However, in this phase, congestion was observed in the corridors with public transport, a specific case being Boyacá Avenue, which has a high flow of buses making trips within Bogotá and the municipalities of the metropolitan area. Because of the high flow of freight and public transport, traffic jams have occurred and the speed of public transport has been reduced from 17 km/h to 5 km/h.
3	76 km	17/03 (afternoon)	In the afternoon, the segment of bike lane in Boyacá Avenue was removed because of the complications generated on public transport.

Phase	Length	Date	Observations
			From March 18 to March 20, measurements of bicycle user flow in the temporary bike lanes were reinforced, resulting in the following definitions for the next steps: ● Improve the connectivity of the existing bicycle network with new temporary sections; ● Focus on the sectors where most of the population lives, also thinking about health care workers; ● Connect the largest dormitory city (Soacha); ● Seek to improve the comfort of bicycle travel, for example, by connecting segments on vehicular bridges to prevent bicycle users from dismounting; ● Improve the travel quality of bicycle users, with temporary segments on those bike lanes that had a high flow of pedestrians or had problems such as potholes and cracks that affected their level of service. It is worth noting here that this characterization of the quality of bicycle infrastructure in relation to inconvenience between pedestrians and bicycle users already existed before the pandemic, associated with an inventory conducted by the IDU. This information is collected by the Secretariat of Mobility, either by complaints from users or by some accident that is mapped.
4	74 km	(25/03)	Following the definitions of Phase 3, the definitive segments were selected. There were 74 kilometers on which were developed traffic regulation actions, orientation of new users, installation of temporary signaling, emergency services such as accidents or others. The operation had the participation of several groups, such as the Guardians of the Leisure Bike Lane and the guides of the program "To school by bicycle", which are programs that work regularly encouraging the use of bicycles, but were suspended because of the COVID-19 situation. There was also police support and a security group aimed at combating bicycle theft, and this support group was already functioning regularly in the city. Due to the high flow of users, the continuing pandemic scenario, and the quarantine, the temporary bike lanes were turned into permanent bike lanes. At the time of this study, 28 kilometers have been built, as shown in Figure 3.

Source: adapted from BAHAMON, 2020.

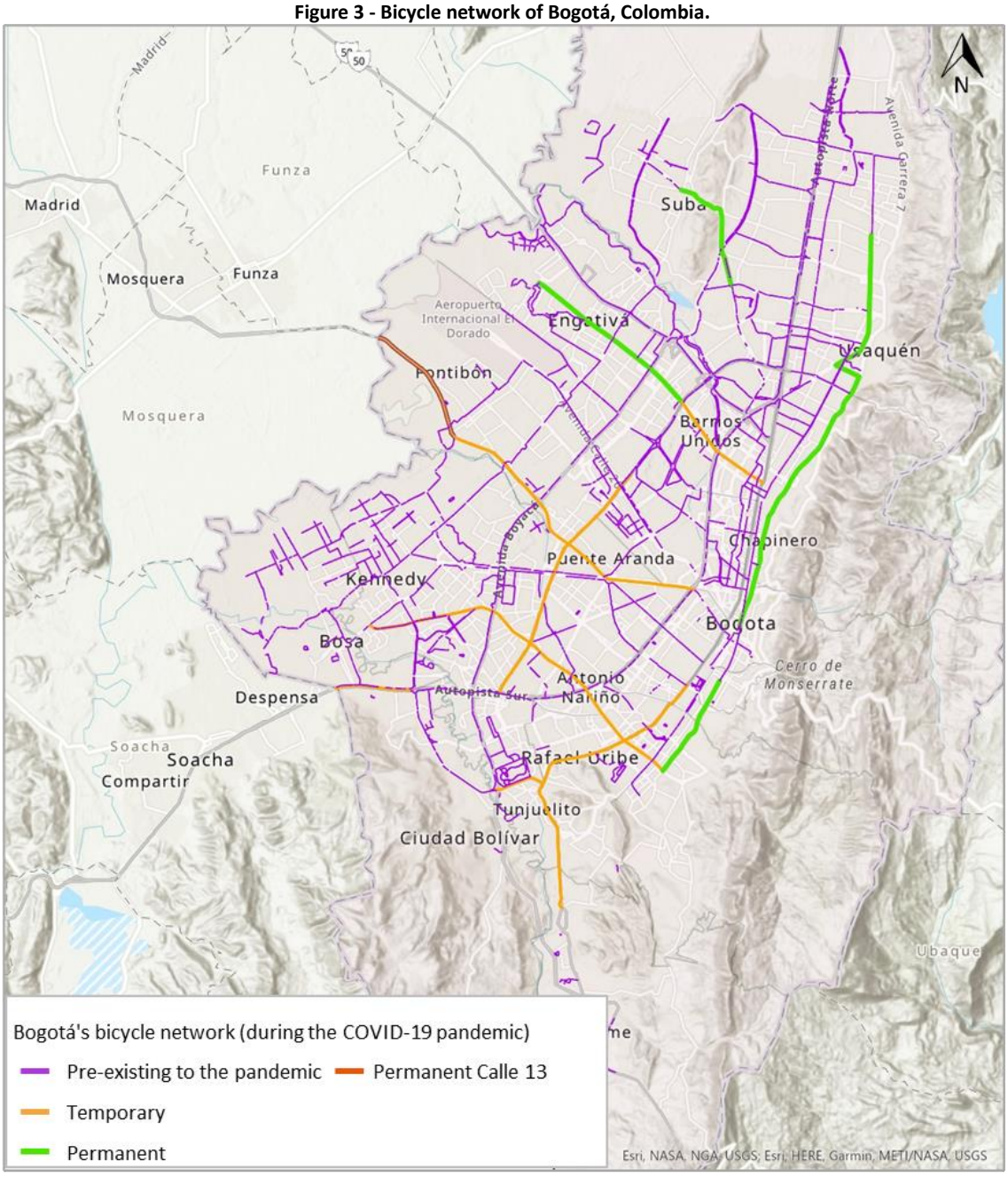
4.2. Research of the implemented infrastructure

Implementing 74 kilometers of temporary bike lanes, which are now becoming permanent lanes faster than usual, made it possible to redistribute space for active mobility modes, allowing interconnection with the existing network, and improving the quality of travel for bicycle users. Figure 3 presents the map of this new infrastructure and Figure 4 shows photos of some of the implemented sections.

It is noteworthy that the Calle 13 corridor, in the western part of the city near the El Dorado International Airport, has a high flow of freight and passenger trips from municipalities in the metropolitan area. In this location, about 4 kilometers of permanent cycling infrastructure was installed in September 2020, but conflicts between cyclists and freight and passenger transport have led to a constant dispute between the city government, industries from the area, and the Government of Cundinamarca (the state where Bogotá is located). On January 19, 2021, Bogotá's city government announced its decision to remove the implemented infrastructure and

move it to the pedestrian sidewalk, returning the space once designated for bicycles to private vehicles. The opinion of bicycle users is that in this new infrastructure they will be more exposed to theft and robbery (EL ESPECTADOR, 2021).

Figure 3 - Bicycle network of Bogotá, Colombia.



Source: adapted from BAHAMON, 2020.

Figure 4 - Segments of implemented bike lanes in Bogotá.

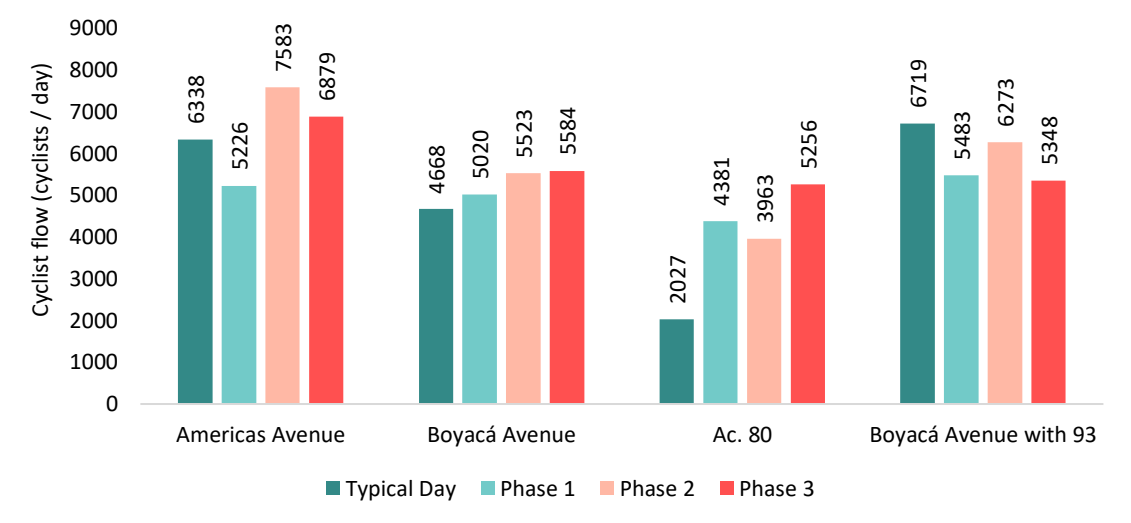
Carrera 7 North	Carrera 7 South
	
Carrera 9	**Calle 13 East**
	
Calle 13 West	**Avenue 68**
	

Source: Created by the authors, 2021.

4.3. Performance analysis after implementing the temporary bike lanes

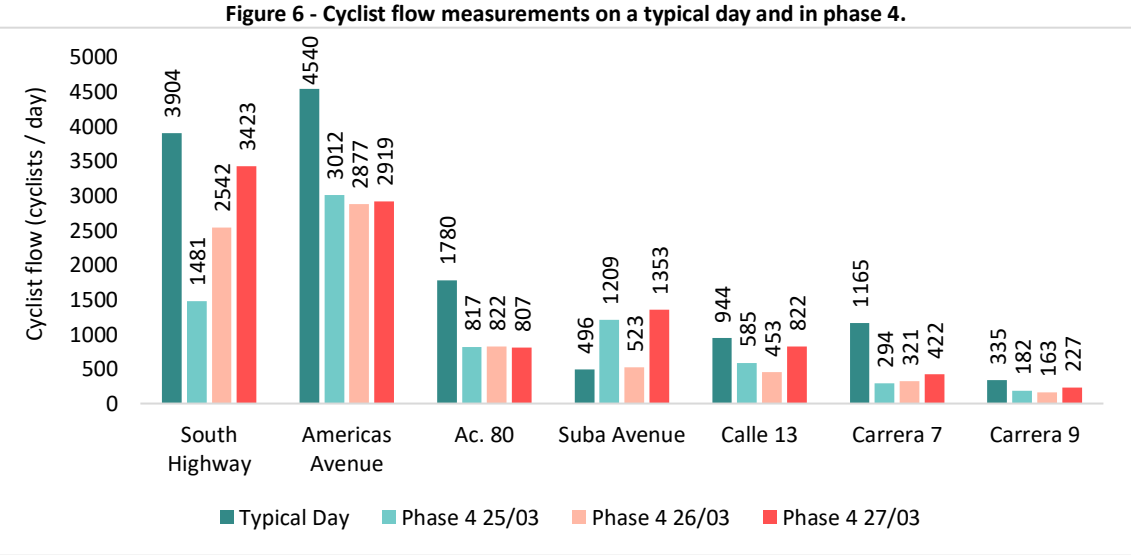
There has been an increase in bicycle use in the city of Bogotá, associated with implementing the temporary cycling segments and the pandemic emergency. The changes in bicycle user flows are presented in Figure 5, with measurements taken on some corridors on a typical day and during the operation period of the temporary bike lanes sections of phases 1, 2 and 3. Figure 6 shows measurements for a typical day and on March 25-26-27, 2020, on the corridors where phase 4 has already been implemented. Measurements on the segments that are now permanent are not yet available. Even if the cyclist flows in the phase 4 measurements did not exceed a typical day before the pandemic, it has to be considered that part of the population can carry out their essential activities without the need to travel because of the pandemic.

Figure 5 - Cyclist flow measurements on a typical day and in phases 1, 2 and 3.



Source: adapted from BOGOTÁ, MOBILITY SECRETARIAT, 2020b.

Figure 6 - Cyclist flow measurements on a typical day and in phase 4.



Source: adapted from BOGOTÁ, MOBILITY SECRETARIAT, 2020b.

4.4. Analysis of aspects associated with implementing temporary bike lanes

Besides the results in the implementation of the bicycle lanes and the increase in the users' flow, another point regarding bicycle use that deserves to be highlighted is the partnership signed between the Municipality of Bogotá and the private shared bicycle system MUVO to provide bicycle loans, without payment, to health workers who belong to the public health network. The measure went into operation on March 29, 2020, with a loan of 400 bicycles per day (SECRETARIAT OF MOBILITY, 2020).

Considering safety issues, some temporary sign posts elements are stolen by homeless people, a social situation that is very particular to a developing country, and over which constant control must be exercised to avoid accidents with cyclists. In addition, taxis and private vehicles invaded some temporary segments because they were unaware of the measure or simply do not understand its importance, and enforcement by police and bicycle guides is vital to avoid accidents (BAHAMON, 2020).

Like most of the population, the group that developed the bike lanes project had a change in the way they worked, with a new learning curve and faster decision making. Sometimes, there was a process of trial and error, as there was no reference to a situation similar to the COVID-19 pandemic in terms of severity and scale.

4.5. Questionnaire

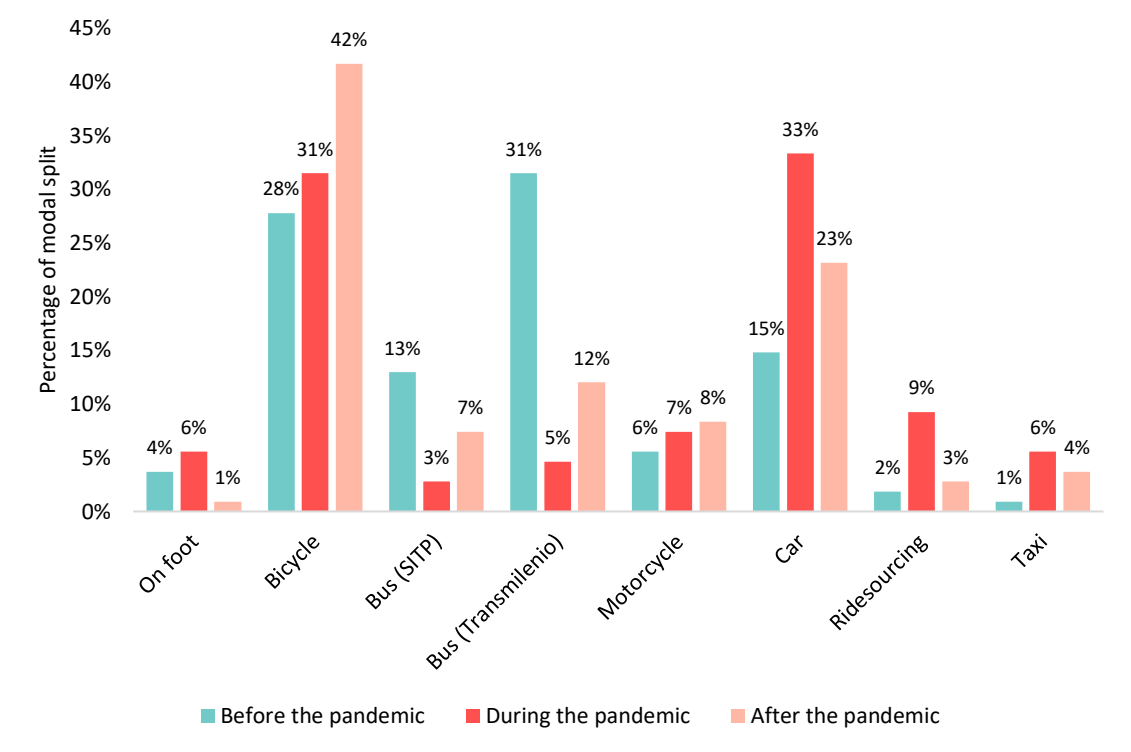
Regarding the stage of perception of city residents concerning temporary bike lanes, 108 responses were collected, of which the sample is characterized as: 44.4% are female and 55.6% are male; regarding age, 2.8% were under 20 years old, 25.9% between 21 and 30 years old, 43.5% between 31 and 40 years old, 20.4% between 41 and 50 years old, 4.6% between 51 and 60 years old, and 2.6% over 60 years old; in relation to occupation, 4.6% declared they were students, 51.9% workers, 20.4% self-employed, 2.8% informal workers, 13.9% public employees, 0.9% retired, 4.6% unemployed, and 0.9% declared they had another occupation. Furthermore, 7.4% received some kind of subsidy from the government during the pandemic and 92.6% did not. Regarding work during the pandemic, 67.6% of the sample kept their jobs, 11.1% changed jobs, 13.0% lost their jobs, and 8.3% did not work before the pandemic. For 54.6% of the sample, family income during the pandemic remained at the same level, for 33.3% income decreased, while 12.0% experienced an increase. In the publicization stage of the questionnaire, many potential participants stated they had already taken part in other pandemic-related surveys, which shows that the online mechanism has a level of strain, and becomes a difficulty in data collection.

4.5.1.Modal split and bicycle trips

To elaborate modal split, participants answered modal choice questions in the scenarios before, during, and after the pandemic. The results are similar to those found by Guzmán *et al*. (2020), and show a drop in public transport modal share during the pandemic. In the post-pandemic scenario, the percentage of this mode will be higher than during, but the rates will be much lower than before. The results found for individual motorized modes revealed considerable increases during the pandemic and maintenance of higher rates in the post-pandemic scenario than before. For the bicycle, the share increased from 28% before to 31% during the pandemic. For the post pandemic scenario, modal share is expected to increase to 42%. All results are presented in Figure 7.

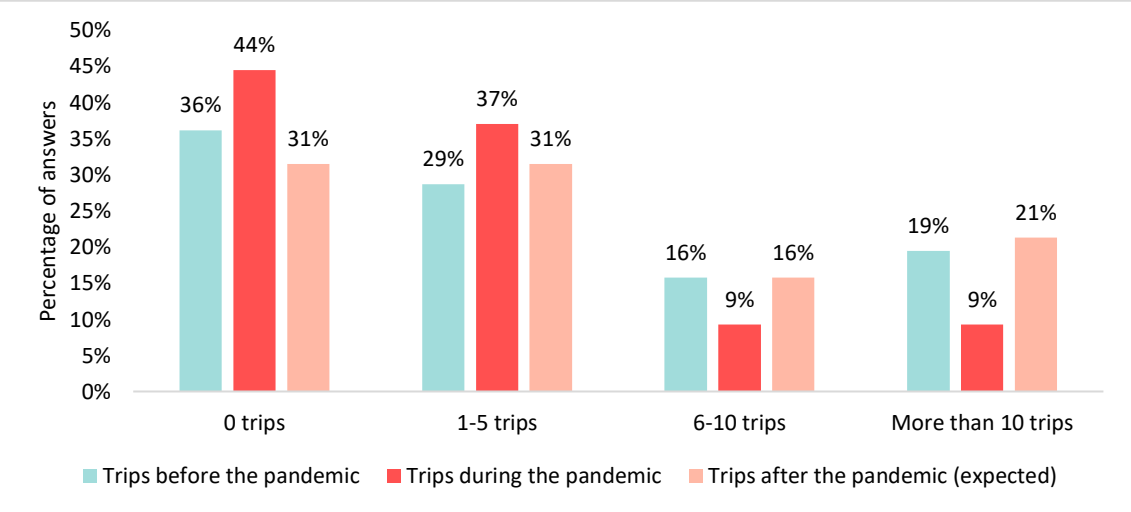
Figure 8 shows the responses for the number of trips by bicycle in the before, during and post pandemic scenarios. During the pandemic, there is an 8% increase in both no trips and 1 to 5 trips, while larger numbers of trips showed a decrease. In the post pandemic scenario, when compared to the before pandemic scenario, there is a decrease in the number of no trips, maintenance of the percentage of 6 to 10 trips, and a 2% increase for 1 to 5 trips and more than 10 trips. The results show that there is an expected increase in the modal share of the bicycle in the post-pandemic scenario.

Figure 7 - Modal split before, during and after (expectation) the COVID-19 pandemic in Bogotá.



Source: Created by the authors, 2021.

Figure 8 - Number of bicycle trips before, during and after (expected) the pandemic of COVID-19 in Bogotá.



Source: Created by the authors, 2021.

4.5.2.Perception of temporary and permanent bike lanes during the pandemic

In one section of the questionnaire, a general evaluation of the bike lanes was made, with questions related to the knowledge of the measures adopted. The results, presented in Table 2, show that 75.9% of the participants are aware of the initiatives, 42.6% have used the temporary bike lanes, and 66.7% agree with the transition from temporary to permanent nature. However, most participants do not consider the bike lanes to be well designed or safe for everyone. The question "How do you evaluate the implementation of temporary bike lanes in

Bogotá as a measure to confront the pandemic of COVID-19?" was also presented, to which 12.0% responded that the implementation was excellent, 35.2% good, 34.3% regular, 9.3% poor, and 9.3% very poor.

Table 2 - Perception of the temporary bike lanes implemented in Bogotá as a measure to face the pandemic of COVID-19.

Question	Yes	No
Are you aware of the initiatives to implement temporary bike lanes in Bogotá?	75,9%	24,1%
Did you use the temporary bike lanes in Bogotá during the COVID-19 pandemic?	42,6%	57,4%
Are the temporary bike lanes well designed?	31,5%	68,5%
Do temporary bike lanes offer safety for everyone?	15,7%	84,3%
Do you agree with the transformation of temporary bike lanes into permanent ones?	66,7%	33,3%

Source: Created by the authors, 2021.

Participants who stated that they used bicycle as their primary mode of transportation during the pandemic were directed to a part of the questionnaire that contained an additional assessment. A total of 47 responses were collected in this part, and about 17.4% of these participants responded they started using bicycles because of the new bike lanes implemented during the pandemic of COVID-19. In this part, there were also statements about the bike lanes, to which participants could respond whether they totally or partially disagreed, were indifferent, or partially or totally agreed. To compare the types of infrastructure implemented, the same statements were presented for the temporary bike lanes and for those that were transformed into permanent. Temporary bike lanes were described as "those marked by cones or other elements and that do not have permanent infrastructure", while permanent bike lanes "are those with permanent infrastructure, whose implementation followed a temporary implementation". The results are presented in Table 3, with emphasis on the decrease in the percentage of disagreement with the statement "The new bike lanes are safe against theft and robbery" from temporary to permanent bike lanes. With the transition to the permanent nature, the percentages of agreement with the statements related to comfort, signaling, and lighting increase considerably.

Table 3 - Perception of temporary (a) and permanent bike lanes (b) in the COVID-19 pandemic in Bogotá.

Affirmations		Totally disagree	Partially disagree	Indifferent	Partially agree	Totally agree
Bike lanes were important for dealing with the COVID-19 pandemic in terms of mobility and transportation	a	6,5%	6,5%	8,7%	32,6%	45,7%
	b	6,5%	6,5%	10,9%	19,6%	56,5%
The new bike lanes are safe from accidents	a	15,2%	10,9%	47,8%	21,7%	4,3%
	b	6,5%	10,9%	47,8%	23,9%	10,9%
The new bike lanes are secure against theft and robbery	a	30,4%	26,1%	30,4%	6,5%	6,5%
	b	23,9%	15,2%	37,0%	19,6%	4,3%
The new bike lanes routes have reduced my commuting time	a	6,5%	4,3%	23,9%	43,5%	21,7%
	b	2,2%	13,0%	15,2%	39,1%	30,4%
The new bike lanes are connected	a	10,9%	17,4%	34,8%	26,1%	10,9%
	b	15,2%	8,7%	34,8%	28,3%	13,0%
The new bike lanes connect important points in the city	a	4,3%	8,7%	32,6%	37,0%	17,4%
	b	6,5%	8,7%	23,9%	43,5%	17,4%
The new bike lanes are comfortable	a	19,6%	10,9%	37,0%	28,3%	4,3%
	b	6,5%	4,3%	32,6%	41,3%	15,2%

Affirmations		Totally disagree	Partially disagree	Indifferent	Partially agree	Totally agree
The pavement of the new bike lanes is of good quality	a	8,7%	32,6%	30,4%	23,9%	4,3%
	b	2,2%	23,9%	26,1%	30,4%	17,4%
The new bike lanes are well signposted	a	23,9%	21,7%	34,8%	10,9%	8,7%
	b	2,2%	26,1%	21,7%	28,3%	21,7%
The new bike lanes have adequate lighting	a	23,9%	28,3%	34,8%	8,7%	4,3%
	b	4,3%	21,7%	39,1%	26,1%	8,7%
The inspection of these bike lanes is very important for their functioning	a	6,5%	8,7%	17,4%	21,7%	45,7%
	b	2,2%	6,5%	10,9%	23,9%	56,5%

Source: Created by the authors, 2021.

5. CONCLUSION

The emergency crisis caused by the COVID-19 pandemic brought about several changes in urban mobility patterns. Several cities have turned to active modes, especially bike lanes, to deal with the spread of the new coronavirus. There is a worldwide trend to build cycling infrastructure quickly, taking advantage of the quarantine times so that travel can be done safely and with social distance, but also ensuring a modal transition in the period after the pandemic. Implementing this cycling infrastructure, under the conditions of the pandemic, allows the understanding of the importance of decisions supported by technical foundations, transport flows, cyclist flows, and travel demand, but also that technical criteria need political support to be implemented.

The cities that were already working with the bicycle as an important element for mobility have greater advantages such as knowledge, information, human resources and acceptability by the population to act in this pandemic scenario. The cities that did not focus on the bicycle and active mobility should take advantage of the difficulties arising from the pandemic to develop infrastructures, and acquire knowledge from the experiences of cities such as Bogotá.

The results of the questionnaire show that the population is aware of the initiatives and that they are well evaluated as measures to face the pandemic of COVID-19. Also, that there is an acceptance of the transformation from a temporary to a permanent infrastructure. However, when safety and infrastructure quality criteria were considered, the temporary bike lanes had negative evaluations, showing the need to restructure the temporary projects.

Finally, although the method adopted by Bogotá has room for improvement, because the process has several complications and changes that arise daily, the solutions adopted by the city contribute with several guidelines for other cities that try to work aspects of active mobility in a pandemic scenario so that the habits acquired during this moment become permanent.

Acknowledgments
This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) – Finance Code 001.

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