Revista Nacional de
Gerenciamento de Cidades
ISSN eletrônico 2318-8472, volume 10, número 78, 2022

The Master Plan for Urban Transport and Mobility of Sorocaba - SP: challenges for the implementation of guidelines aimed at sustainable transport modes

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ABSTRACT

The last decades have been marked by profound economic and social changes, which have significantly altered the population's way of life. Among the main effects of urban agglomerations are changes in the transportation and mobility system that still represent a challenge for municipal management, especially in medium and large cities. As of Federal Law No. 12,587, dated January 3, 2012, all Brazilian municipalities with a population of over 20,000 inhabitants were required to prepare an urban mobility plan. In Sorocaba, the proposals directed to the requirements of this legislation are in the Urban Transportation and Mobility Master Plan (acronym in Portuguese, PDTUM), prepared between 2012 and 2013 and implemented in 2016. Aiming to analyze urban mobility in Sorocaba, this article brings a descriptive and partial evaluation of the guidelines contained in the PDTUM document related to non-motorized transport and public transport and its implementation in the municipality. For this analysis, some indicators of the Sustainable Urban Mobility Index (IMUS), developed by Costa (2008) are used, consisting of an important tool for mobility management and public policy formulation from the perspective of sustainability. Regarding the actions planned and already adopted in the municipality, some show efficiency and a need for expansion so that the improvements can be increasingly comprehensive. The results contribute to tracing a more precise scenario for mobility in Sorocaba and can be useful for other cities whose plans are under development or revision.

KEYWORDS: Urban Mobility Master Plan. Urban Mobility Policy. Transport.

1. INTRODUCTION

The intense occupation of urban territory, especially in cities whose growth has occurred at an accelerated pace, has created highly complex urban challenges, mainly related to transportation. Limited or undefined urban planning, illegal appropriation of public space, and reduced afforestation rates, among others, characterize most large Brazilian centers. As congestion is generated, actions - usually aimed at the increase of road capacity - end up stimulating car use which, in addition to new congesting, reflects in damages such as the degradation of air quality and segregation of people, among others, affecting the quality of life in cities (BERGAMINI, 2015).

The essential activities for life in contemporary cities - commercial, industrial, educational, etc. - are possible only with the movement of people and products. Thus, in the face of the new demands, public power interventions often prioritize the growth of municipalities and disregard environmental aspects and universal access to services (FERRAZ; TORRES, 2004).

According to Maricato (2011, p. 79), among the factors that contribute to the decline of quality of life in metropolitan areas is "the mobility model based on the road matrix, especially in the car, and the relative disregard for public transportation are, perhaps, the ones with the greatest impact". For Bergamini (2015), Costa (2008) and Magagnin (2008), the current mobility pattern centered on personal motorized transportation proves to be unsustainable, both concerning environmental issues and the ability to meet urban demands.

The Sustainable Urban Mobility policy in Brazil aims at providing the development of cities based on the principles of Sustainable Urban Mobility which incorporate three main axes: i) Urban Development; ii) Environmental Sustainability and iii) Social Inclusion (MAGAGNIN; SILVA, 2008).

In short, sustainable urban mobility represents the search for economic and social development combined with environmental concerns. According to Costa (2008), cities that implement sustainable mobility policies ensure greater dynamism of urban functions, expanding and improving the circulation of people and goods (and services).

In this context, the promulgation of Federal Law No. 12,587/12 comes to contribute to the integrated and sustainable planning of cities in the country since its content brings the principles and guidelines for the preparation of Urban Mobility Plans (PMU) for municipalities with more than 20 thousand inhabitants (BRASIL, 2012).

For Litman (2013), some planning models focus on the mobility that favors the fastest means of locomotion and, therefore, attribute to non-motorized travel, on foot or by bicycle, a character of inefficiency. For the author, the planning thought for the automobile imposes barriers to non-motorized modes. In contrast, those based on sustainable travel, on active and non-motorized modes, in addition to the collective ones, represent the structure of the transportation system.

Linking urban development and new transport and mobility demands to environmental and social issues involves decisions that significantly affect the population's quality of life. Thus, to achieve the sustainability of urban mobility, it is necessary to reorder the dynamics and invest in other locomotion systems, such as non-motorized and collective transportation.

Therefore, the search for a sustainable urban mobility monitoring method, applicable to any municipality, is based on several studies. In this scenario, stand out those that use performance indicators, which, according to Costa (2003), are instruments that reduce a large amount of information to adequate parameters for analysis and decision-making. According to IBGE (2015), the sustainable development indicators are important to guide the actions and allow the monitoring and evaluation of the implementation of municipal actions focused on sustainable development.

The Sustainable Urban Mobility Index (acronym in Portuguese, IMUS), developed by Costa (2008), in this context, represents an important tool for the management of mobility and the formulation of public policies from the perspective of sustainability. Through extensive research on the relationship between urban mobility and quality of life in the city, IMUS presents a structure based on a set of indicators that enable reflection on various parameters associated with mobility.

Costa (2008) emphasizes that Mobility Plans must have characteristics adapted to local realities and that the number of indicators used must vary according to the target audience to whom the information is addressed.

2. OBJECTIVE

This paper presents a comparative analysis between the guidelines related to sustainable urban mobility present in the Urban Transport and Mobility Master Plan - PDTUM of Sorocaba - with emphasis on the analysis of collective and non-motorized transport modes - and the existing infrastructure in the municipality.

3. METHODOLOGY

From a qualitative approach, the case study on the theme of sustainable urban mobility in the city of Sorocaba (SP) carries out a comparative evaluation between the municipal legislation of Sorocaba's mobility plan and the diagnosis of the existing infrastructure in the city. To this effect, it uses two analysis stages as methodology: (1) definition of themes and sub-themes related to sustainable urban mobility to evaluate Sorocaba's Urban Transportation and Mobility Master Plan (PDTUM) and (2) analysis of the sustainable urban mobility infrastructure (public transportation and active modes).

From the bibliographical review of studies conducted in Brazil on sustainable urban mobility (COSTA, 2008; MAGAGNIN, 2008; BORN, 2011; VASCONCELLOS, 2014), some topics related to sustainable urban mobility were defined, which enabled the evaluation of the available infrastructure in some areas of the municipality and the PDTUM.

Based on the research developed by Costa (2008) entitled "Sustainable Urban Mobility Index (IMUS)", the elements (themes and sub-themes) that allow investigation of the PDTUM and the infrastructure aimed at sustainable urban mobility in Sorocaba were defined.

The IMUS tool can be used in the stages of diagnosis and monitoring of several parameters (themes) related to sustainable urban mobility in municipalities. Its hierarchical structure is composed of 09 Domains, 37 Themes, and 87 Indicators. This article only uses the IMUS hierarchical structure (domains, themes, and indicators) and their respective definitions (Table 1).

Table 1: Definition of the Domains, Themes, Indicators and their respective source for obtaining data.

Domain	Theme	Indicator	Baseline data
05 Transport Infrastructure	5.2 Distribution of transport infrastructure	Public transport routes.	Map of urban bus lines.
06 Non-motorized modes	6.1 Bicycle transport	Extension of bicycle paths.	Map of bicycle paths.
		Bicycle parking.	Urban public transport stations. Urban public transport terminals with bicycle parking.
	6.2 Travels on foot	Streets with sidewalks.	Map of streets and footbridges.
09 Urban transport systems	9.1 Availability and quality of public transport	Extension of the public transport network.	Map of public transport routes.
		Users´ satisfaction with public transport service.	Surveys with the users.
	9.2 Integration of public transport	Integration of public transport	Actions, plans, and projects for the integration of public transport.

Source: COSTA (2008, p. 187-194). ADAPTED BY THE AUTHORS, 2022.

The IMUS Domains, Non-Motorized Modes and Urban Transportation Systems, are references to analyze the PDTUM and the infrastructure aimed at sustainable urban mobility in the city of Sorocaba (Tables 2 and 3). To evaluate the PDTUM, the following parameters are adopted: i) Diffuse, when the theme has objectives and guidelines that cover the entire territory of the city; ii) Sectored, when proposals cover only one region of the city; and iii) Without identification, when there is no proposal or guideline identification in the law (Table 2).

Table 2: Evaluation Model of PDTUM of Sorocaba.

Theme	Indicator	PDTUM Guidelines and Proposals	Evaluation
“n” Theme	”n1” Indicator	Transcription of the law	Diffuse/Sectorized/No identification

Source: AUTHORS, 2022.

The analysis of the mapping of the sustainable urban mobility infrastructure available in the city is presented by means of a summary table, containing qualitative and quantitative information on each mode of transport evaluated (Table 3).

Table 3: Summary table with the urban mobility infrastructure evaluation model.

Transport mode	Indicator	Description	Evaluation
On foot or Bicycle or Bus	"n1" Indicator	Description of information, which may be qualitative and/or quantitative.	Fully met / Partially met / Not met
Legend:			
Fully met		**Partially met**	**Not met**
100% of the city is served by urban mobility infrastructure.		Up to 50% of the city is served by urban mobility infrastructure.	Less than 25% of the city is served by urban mobility infrastructure.

Source: AUTHORS, 2022.

Given the need for social isolation, both within Brazil and abroad, due to the Pandemic caused by the COVID-19 virus, and aiming to contribute to the reduction of virus transmission, the data survey on mobility infrastructure was conducted through the use of software, associating street images and online geographic maps such as Google Maps, Google Street View and Google Earth Pro. These tools can assist studies that involve evaluation at micro or macro scales (SENNA; MAGAGNIN; FONTES, 2021).

4. ANALYSIS AND DISCUSSION OF RESULTS

Located in the southwestern region of the São Paulo state, approximately 90 km from São Paulo, Sorocaba has an estimated population of 695,328 inhabitants (IBGE, 2021). An important industrial hub in the country, the municipality is part of the Metropolitan Region of Sorocaba (RMS), being composed of 27 municipalities. Grouped into three sub-regions, they have approximately 2,06 million inhabitants (IBGE, 2021).

The development of Sorocaba urban network was strongly influenced by commerce and people circulation, and the process is portrayed in the urban space to the present day (CELLI, 2012). Thus, the presence of dispersed urban nuclei leads to the formation of more peripheral neighborhoods, such as Eden.

With low densification and a more sprawling city, the dependence on motorized transportation increases, and, furthermore, services and actions of the municipal public power concentrate in some specific areas.

Sorocaba's road system is mostly made up of arterial and collector roads and does not include municipal highways. The state highways that connect to the municipal road system are of fast transit and are also widely used in the urban mobility of the population (SOROCABA, 2016).

The road structure is characterized mainly by peripheral arterial roads that converge to the central region, where there is a perimeter ring that distributes the circulation between the neighborhoods and the center. One of the negative consequences of this model is the saturation of the downtown streets, as they are already limited due to the concentration of commerce and services, as occurs in many medium-sized cities in São Paulo.

This development model is reflected, among other characteristics, in the expansion of the vehicle fleet. The increase in the number of vehicles represents a factor inherent to the growth of most urban centers in Brazil and, however, constitutes one of the greatest challenges: the issue of accessibility and mobility in the management of metropolitan spaces.

In Sorocaba, individual motorized transport is still very expressive, which is demonstrated by the continuous growth of the vehicle fleet. Between the years 2010 and 2021, the vehicle fleet had a significant increase (51.8%) in comparison to the population growth (18.5%). The population increased from 586,625 inhabitants (IBGE, 2010) to 695,328 inhabitants in 2021 (IBGE, 2021). Meanwhile, the vehicle fleet went from 324,708 vehicles in 2010, to 493,210 vehicles in 2021. In this same period, only the car fleet grew 47%, as it went from 215,819 cars to 317,835 cars. This growth was also identified in the motorbike fleet, with an increase of 51%, evolving from 56,661 motorbikes in 2010 to 85,645 motorbikes in 2021 (IBGE, 2010; 2021).

This dependence on the use of individual motorized transport brings about a great impact on traffic flows, causing the reduction of mobility and accessibility indexes, in addition to problems such as the increase in air and noise pollution; an increase in the number of traffic accidents, among others (MAGAGNIN; SILVA, 2008).

Given this scenario, and to meet Federal Law 12,587/12, which established the National Policy of Urban Mobility, the municipality developed the Master Plan of Urban Transportation and Mobility of Sorocaba (PDTUM), approved in 2016 through Municipal Law No. 11.319.

The PDTUM proposes actions and guidelines in order to plan a better management of the city, contemplating: Urban Plans/Demand Management; Road System; Collective Transportation; Non-motorized Transportation, and Freight Transportation. Focused mainly on the expansion of the road system, the PDTUM has some characteristics that differentiate it from other mobility plans of medium-sized cities due to the fact that the municipality has implemented some short, medium, and/or long-term actions focused on mobility before the development and implementation of this Plan.

The analysis of mobility in Sorocaba focused on the proposals of the Non-motorized Transport and Collective Transport axes. Thus, the evaluation of each selected item is presented in two parts: the first describes the synthesis of the proposal contained in the PDTUM, and the second, the current situation of mobility in the municipality in relation to the specific guidelines.

Sorocaba’s Mobility Plan met 30 of the 47 items of the Urban Mobility Plan primer (PlanMob[1]) and its guidelines are distributed among the three implementation terms, with

[1] In 2013, after the promulgation of Federal Law 12,587/12, the former Ministry of Cities developed a primer with general guidelines for the preparation of mobility plans. In 2015, the PlanMob booklet was released, its content elaborating on the previous document and providing guidelines on the components of the mobility systems.

greater emphasis on the medium and long terms (Table 4). When detailing the proposals/guidelines, the PDTUM describes: the implementation term, justification, methodological details/procedures, and pre-feasibility. In the last part of the Plan, there is a chapter dedicated to the economic and financial evaluation of the projects (SOROCABA, 2016).

Table 4: PDTUM proposals classified by system axis and implementation deadline.

Axis	Proposal/guideline	Implementation deadline
Urban Plans/ Demand Management	Urban Development in the Corridor Surroundings (TOD).	Short/Medium/Long.
	Parking Management.	Short/Medium/Long.
	Anti-Visual Pollution Policy.	Short/Medium/Long.
	Urban Toll (Guideline).	Long +
	Plate Rotation (Guideline).	Long +
Road System	Road System Package of Priority Road Projects.	Short/Medium/Long.
	“Integral Roads” (Guidelines).	Short/Medium/Long.
	Smart traffic lights.	Short/Medium/Long.
	Park & Ride Parking Spaces (Guideline).	Medium.
Public Transportation	Transport BRT Corridors (System rationalization).	Short/Medium.
	BRT Expansion and Priority Corridors (BRS).	Medium/Long.
	Suburban Terminal (Guideline).	Medium.
	Suburban Terminal (Guideline).	Medium.
	Regional Train (Guideline).	Medium.
	LRT (Guideline).	Long.
Non-motorized Transport	Sidewalk Plan (Management).	Short/Medium/Long.
	Shelter Access Plan.	Short/Medium.
	Bicycle path plan - maintenance and expansion.	Short/Medium/Long.
	“Wayfinding” Orientation Plan (Guideline).	Short/Medium/Long.
Freight Transport	Increase Time Restrictions on BRT Corridors.	Short
	Rail Link (Guideline).	Long.
	Intermodal Freight Distribution Centre (Guideline).	Long.

Source: Authors, based on Sorocaba, 2016.

Regarding the content of PDTUM, the analysis related to the topics Non-Motorized Modes, Transportation Infrastructure and Urban Transportation Systems, points out that most indicators are present in the content of the plan in a diffuse form, i.e., the actions or guidelines should be implemented for the city as a whole (Table 5).

Table 5: Summary table of the evaluation of Sorocaba PDTUM.

Theme	Indicator	PDTUM Guidelines and Proposals	Evaluation
Travels on foot	Roads with sidewalks	Focused on revitalizing pavement and increasing pedestrian safety, presented in three parts: Plan for standardization, prioritization, and requalification of sidewalks; Implementation, inspection and management of sidewalks and Educational Programs.	i) diffuse citation.
Bicycle Transportation	Extension and connectivity of bicycle paths	Proposes to extend the network for an additional 120 km, expand the public bicycle system, improve connectivity, maintain the existing bicycle network and improve the general conditions of bicycle paths.	i) diffuse citation.
	Bicycle parking	Points out that bicycle parking facilities are essential at points with a higher flow of cyclists, such as terminals.	ii) sectored citation.
Distribution of transport infrastructure	Lanes for public transport	Predicts the implementation of approximately 35 km of corridors and exclusive lanes, 51 level stations in the corridors and 65 shelters at bus stops in the exclusive lanes. Suggests the installation of bicycle racks and/or stations of the *Integrabike* system annexed to the stations.	i) diffuse citation.
Availability and quality of public transportation	Extension of the public transportation network	In principle, points out that there is no need to create exclusive lanes. Expansions of BRT, BRS corridors and "Axes", according to PDTUM, should include as much as possible the same elements of upgrading and priority cited for BRT corridors.	i) diffuse citation.
	User satisfaction with public transport service	----	iii) no proposal or guideline identified in the law.
Integration of public transport	Integration of public transport	Improvement of bicycle lanes connectivity, expansion of *Integrabike*, expansion of BRT and priority corridors (BRS).	i) diffuse citation.

Source: AUTHORS, 2022.

The assessment of the urban mobility infrastructure revealed that most of the indicators were partially met, highlighting two of the indicators as the only ones not met (Table 6).

Table 6: Summary table of the evaluation of the urban mobility infrastructure.

Transport mode	Indicator	Description	Evaluation
Non-motorized or active transportation (walking and cycling)	Roads with sidewalks	Sidewalks Plan guidelines aim at reaching all city regions. The only action found was a temporary measure for widening pavements. Lack of effective implementation of proposals.	**Partially met.**
	Extension and connectivity of bicycle paths	With 127 km of bicycle paths, they still do not serve the city as a whole. Connectivity missing in some stretches and connection with other modes of transport.	**Not met.**
	Bicycle parking	Total of 70 paracicles, one of them for 60 bicycles located at Terminal Santo Antonio. Thus, they do not meet the public transportation terminals or the city's demand.	**Not met .**
Distribution of transport infrastructure Lanes for public transport	Roads or collective transport	Delivery of the 1st phase of the BRT Sorocaba, in August 2020, connecting Terminal Vitória Régia to the southern edge of the city.	**Partially met.**
Public transport	Extension of the public transport network.	Of the three BRT corridors planned, two are in operation, the Itavuvu, inaugurated in August 2020 and the Ipanema, inaugurated in April 2021. The third corridor, the BRT Oeste, is not yet in operation.	**Partially met.**
	Users´ satisfaction with the public transport service	Sensor Survey indicates that 72% of users consider the service excellent or good.	**Partially met.**
	Integration of public transport	Relative to the BRT project and the Bicycle Path Plan, the integration measures, even if initial, were favored with the operation of the BRT, Integrabike Program, among other factors. Thus, a more comprehensive integration in relation to the city's demands is missing.	**Partially met.**

Source: AUTHORS, 2022.

The analysis of non-motorized modes concentrates on the two unmet indicators: extension and connectivity of bicycle lanes and bicycle parking. Thus, it is clear that bicycle transportation, one of the most present themes in PDTUM, should be prioritized in the actions, especially because there is a dispersed urban network in the city.

Sidewalk Plan (management) - With measures to be implemented in the short, medium, and long term, the proposal summarized in PDTUM for sidewalks is aimed at revitalizing the sidewalks and increasing pedestrian safety, and is divided into three parts i) Plan for the standardization, prioritization, and requalification of sidewalks(describes the measures regarding the prioritization of roads for the improvement of sidewalks, widening of sidewalks, treatment of corners, among other issues); ii) Implementation, enforcement and the management of sidewalks and iii) Educational Programs (based on examples from abroad, proposes campaigns for pedestrian safety, walking, walking to school, among others).

After the approval of the PDTUM, the municipality carried out a temporary intervention (from February 16 to March 23, 2019) for the widening of sidewalks in a 255-meterlong stretch in the central region of the municipality (Penha Street between the intersections of Miranda de Azevedo, Padre Luiz and Coronel Benedito Pires streets). The proposal consisted of painting a 1.5 m wide strip on the street sidewalks (Figure 1) increasing the total width of the sidewalks. The sidewalks between Miranda de Azevedo and Padre Luiz measure 1.80 m on one side and 2.10 m on the other side, and between Padre Luiz and Benedito Pires there is 1.90 m and 1.50 m.

A survey conducted by the municipal agency that manages urban mobility in the municipality, URBES, mentions that 70.6% of respondents would like this intervention to be permanent and 55.9% approved the new street design. However, the municipality did not implement this proposal. Thus, in relation to the Sidewalk Plan, the proposals contained in the Plan have not been implemented.

It can be observed in several districts of the city that sidewalks lack maintenance of the floor, including pavements shared with bikeways, in which there is no clear division between lanes, impairing the movement of pedestrians and cyclists. Technical studies recommend the implementation of pavements shared with bicycle lanes only as a last resort, as it makes it difficult to adjust the infrastructure for pedestrians and cyclists.

In general, pavements located in areas of tourism and leisure interest, such as in municipal parks and on the city's marginal areas, receive more frequent maintenance and offer better infrastructure for pedestrian travel.

Figure 1: Expansion of sidewalks

Source: CRUZEIRO DO SUL NEWSPAPER/ EMÍDIO MARQUES, 2019.

Figure 2: Bikeway in Sorocaba

Source: URBES, 2022a.

Bicycle Paths Plan - Maintenance and Expansion - With short, medium and long-term measures, the PDTUM proposal for the Bicycle Paths Plan is focused on the integration and expansion of the existing network and is divided into bicycle path infrastructure and educational actions.

PDTUM proposes to extend the cycling network for another 120 km and expand the public bicycle system, Integrabike. Regarding Integrabike, the plan foresees the installation of public bicycle stations near the future BRT/BRS corridor stops to encourage the use of more sustainable transport modes in the city. The plan foresees the improvement of connectivity, the maintenance of the existing cycling network, and the improvement of lighting, shading and signaling conditions on the bike paths. It also suggests the integration of the bicycle with other modes of transport, the bus system, and with the city, which may favor traveling in the urban network due to the very steep relief in the city. It also proposes the construction of cyclist support points in long bicycle paths and in those located in areas with scarce urban fabric.

Regarding the cycling infrastructure, in 2007, the municipality built the first 35 km of bikeways. In 2013, the year of the development of PDTUM, the city had 115 km of bicycle paths, whose expansion was planned in the plan (SOROCABA, 2016).

In recent years, the actions of the public authority turned to the revitalization of bicycle paths. The sections located on marginal roads of the city are better structured and focused on leisure and tourism activities. Mostly concentrated in the North Zone, the cycling infrastructure consists of 118 km of segregated lanes (Figure 2) and 9 km of exclusive lanes shared with the bus (URBES, 2022a). In total, there are 70 paracycles, one of which was implemented at Santo Antônio public transportation terminal with a capacity for 60 bicycles, and, nevertheless, they do not serve the public transportation terminals (URBES, 2022a).

An important factor to be considered for the proper design of bicycle paths is the rugged relief of the city. As Zanettini (2018) points out, the relief and urban form are directly linked to the implementation and success of a cycling network. The author describes that cities like São Paulo and Sorocaba, despite being mountainous, feature extensive fluvial network, flat or gently sloping paths and thus, better solutions can be adopted for the cycling network. Bicycle paths on stretches with large gradients make the trip more tiring and discourage their use, especially for work commuting.

The bike-sharing program, *Integrabike*, had 19 stations in 2016, the year of PDTUM implementation. In 2020, it made 25 stations and 250 bicycles available to the population (URBES, 2022a). Among the main problems of the system is the small number of bicycles for the population and the concentration of stations in the central region of the city, which is a more commercial area and has few houses, so the presence of public bicycles does not favor work trips.

Deactivated since October 2020, the program is currently awaiting the change of the company that will continue to manage the program[2]. According to information from the City Hall, the new contract provides for modernizations in the bike sharing system, installation of cameras in the 15 stations, 315 stopping places, and 210 bicycles in total, 165 for adults and 45 for children. The stations will be modernized and the bicycles will have an ergonomic design, anti-theft system, and night signaling deflectors, among others.

The concentration of actions for bicycle and BRT infrastructure in the North Zone of the city is justified in PDTUM because the North and Northeast regions (Industrial Area) concentrate a larger number of absolute jobs in the city. The West and Centre regions have the highest density and the North Region has many highly densified areas, housing 50% of the population. Also, according to the document, due to a large number of industrial jobs, there is a greater demand for charter bus services and improvements in the Collective Transport infrastructure in the North, Northeast and East regions. Thus, the main BRT and BRS corridors proposed will serve the places with higher population and employment densities (SOROCABA, 2016).

In the assessment of public transport, the evaluation is faced with indicators that are partially met, under great influence of the measures aimed at the BRT system.

BRT Corridors (Rationalization of the System) - With short-term measures, the proposal

[2] Mobhis Automação Urbana Ltda. won the bidding and, as of the signing, will undertake the service for 30 months and has up to 90 days to implement the system.

summarized in PDTUM for this topic foresees the implementation of approximately 35 km of corridors and exclusive lanes, 51 level stations in the corridors and 65 shelters for bus stops in the exclusive lanes. It also suggests the installation of bicycle stands and/or stations of the Integrabike System at points annexed to the stations.

The analysis of the measures implemented begins with the first phase of the Sorocaba BRT which, on August 30, 2020, activated the Itavuvu/Vitória Régia Terminal corridor and connected the terminal to the southern end of the city. It enabled users to board at the terminal, at one of the 12 stations on Itavuvu Avenue, or at one of the 44 stops on the structural corridors. At this stage, 43 vehicles were provided with air conditioning, USB sockets, wi-fi, camera monitoring and information panels for passengers.

BRT Expansion and Priority Corridors (BRS) - With medium- and long-term implementation, the proposal for BRT expansion and implementation in Priority Corridors (BRS) describes that, in principle, there will be no need for the creation of exclusive corridors. Expansions of BRT, BRS Corridors, and "Axes," according to the document, should include as much as possible of the same elements of upgrading and priority cited for BRT corridors.

So far, the latest expansion is the so-called 2nd phase of the Sorocaba BRT which, on April 25, 2021, inaugurated the Ipanema Corridor/São Bento Terminal, connecting the northern zone to downtown. It provided 37 vehicles with lifts, and adapted for people with special needs, in addition to the implementation of 10 boarding stations on Ipanema Avenue.

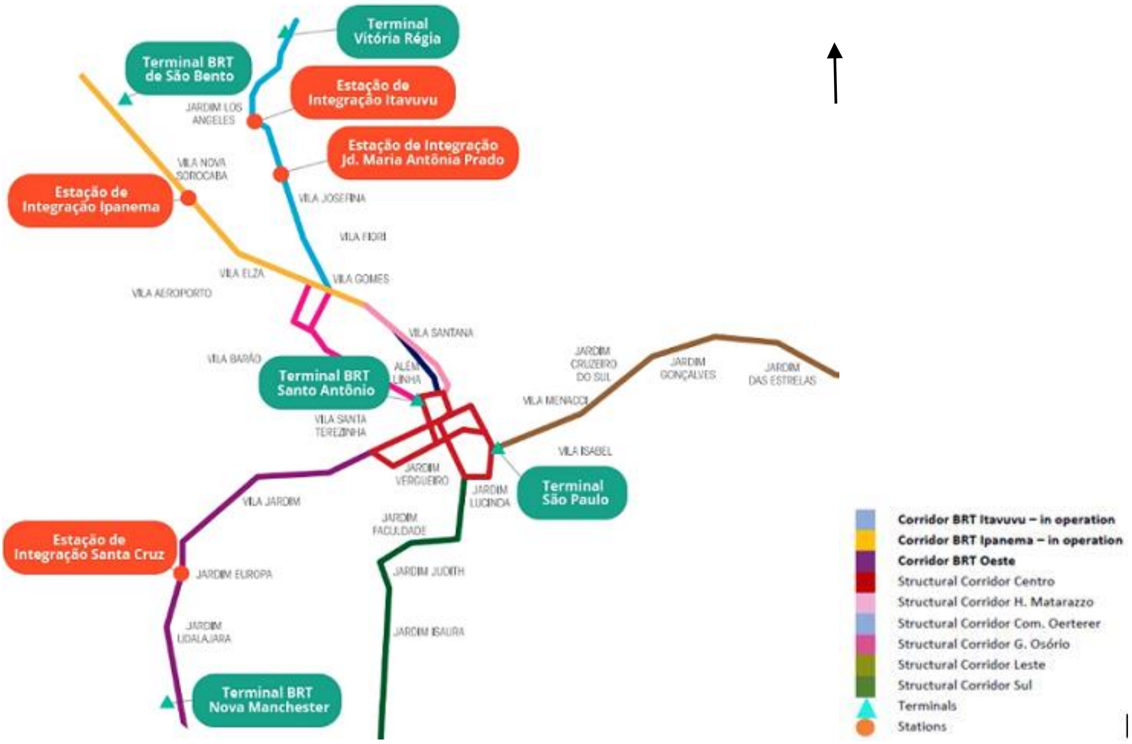
In the current BRT Corridors scenario, regarding BRT Expansion and Priority Corridors (BRS), we highlight i) the implementation of the CittaMobi application and ii) the execution of the Sensor Research.

The CittaMobi application allows users to consult the lines, schedules, bus waiting time and, since November 2020, to pay the ticket fare via mobile phone. With a route planner, it informs if there is the need to walk during part of the trip, which bus must be taken, the departure location and time. It has a communication channel to report problems and suggestions, as well as a button for emergencies, such as harassment or other types of violence. There is a version for the visually impaired, the Cittamobi accessibility, which uses sound and vibration alerts for the same functions of the application (URBES, 2022b).

The Sensor Research, conducted in April 2021, assessed the level of satisfaction of the BRT user in the city. Commissioned by BRT Sorocaba and carried out in partnership with ANTP, the consultation was carried out through the Cittamobi application and shows that 72% of users consider the service excellent or good. For the concessionaire, these results are consequences, above all, of the technology and comfort employed in the vehicles (ANTP, 2021).

In the general scenario of BRT and Priority Corridors (BRS), the project calls for a total of 68 km of BRT corridors, 125 buses, 3 terminals, 6 structural corridors, 3 BRT corridors (Itavuvu, Ipanema, and Oeste), 24 km of exclusive lanes, 28 stations, 1 garage and 4 integration stations (Figure 3). However, of the three planned BRT corridors, only two are in operation, connecting the North Zone to downtown: Itavuvu, with 12 stations, and Ipanema, with 10 stations.

Figure 3: BRT project and corridors in operation



Source: adapted from BRT Sorocaba, 2022.

The BRT stations were built on the ground level, enhancing accessibility for users. Most sections of the project are concentrated in the northern part of the city, a region where public transport is more heavily loaded (SOROCABA, 2016).

The BRT Sorocaba concessionaire is Brazilian and formed by the companies CS Brasil and MobiBrasil and the concession contract, signed on 09 February 2020, lasts 20 years and involves the construction and operation of the BRT. Thus, it represents the first PPP (Public Private Partnership) in Brazil for a BRT with this type of contract. Responsible for the implementation, operation, and maintenance of the system, it is also in charge of the construction or requalification of the roads and bikeways that suffered some intervention as a result of the project.

In 2020, the year the BRT was inaugurated, the monthly average of passengers in public transport was 1,811,143.17, while in 2019 it was 3,781,028.58, a drop that may be a result of the COVID-19 pandemic, which since March 2020 has changed the dynamics of the city as a whole. The numbers grew again, and the average in 2021 was 2,778,970.67 passengers (URBES, 2022c), an increase that can be explained, among other factors, by the return to face-to-face work.

The implementation of the BRT was an important milestone for transport in the city. So far, there is a total of 80 new buses in circulation with free wi-fi, USB sockets, internal monitoring cameras, and air conditioning. Another facility is the payment of a single fare that allows users to make up to three changes within an hour.

5. CONCLUSION

This article aims to analyze the Master Plan of Urban Transportation and Mobility of Sorocaba - PDTUM with emphasis on the proposals related to public transport and non-motorized transport, from some domains and indicators of the Sustainable Urban Mobility Index - IMUS. The results obtained in this analysis can help mobility management in other cities, especially in medium-sized ones, whose transportation system has characteristics in common with Sorocaba.

The actions foreseen in PDTUM are, in general, aimed at prioritizing public transportation and reducing individual motorized transportation. The bicycle is present in the plan's guidelines through the expansion of bike lanes and the bike-sharing system, among other measures. Positive points were identified in PDTUM and some gaps that can be addressed in future revisions, such as the absence of proposals for evaluation and monitoring of mobility.

Regarding the actions planned and already adopted in the city, some of them show efficiency and need to be expanded for more comprehensive improvements. Sorocaba stands out in the national mobility scenario for having a Mobility Plan since 2016 and having some important actions even before its implementation, such as the bicycle path network, which started in 2007. Another standout is the BRT, whose results so far are very positive, such as the Sensor Research that, conducted with users in 2021, evaluated the system as great or good.

Regarding the main problems found in the current mobility scenario, there are the concentration of the cycling infrastructure and the BRT in the northern part of the city; the lack of effectiveness of the proposals to improve pavements, and the paralysis of the cycling lanes expansion project, which still do not serve the city as a whole. The steep relief is another relevant factor in cycling interventions and projects in the city, as it can create conditions that hinder the daily use of bicycles.

As a suggestion for the continuity of mobility studies in Sorocaba, it is recommended to extend the analysis to other PDTUM proposals so as to expand the diagnosis. Another recommendation consists of the application of the IMUS, an instrument whose calculation could provide a more precise investigation of mobility in the municipality.

Sorocaba is in continuous transformation and the scenarios presented here may undergo changes, since they contemplate the conditions found up to the moment this work was structured. The PDTUM foresees important actions, but the effectiveness of the proposals comes from the public power and is essential for the tools adopted in the management to respect the characteristics of the population and reach effective solutions for the city.

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