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CIDADE DE SÃO PAULO

INCLUSIVE EDUCATION INITIATIVE
Transforming Education for Children with Disabilities

# SÃO PAULO SMART MOBILITY PROGRAM

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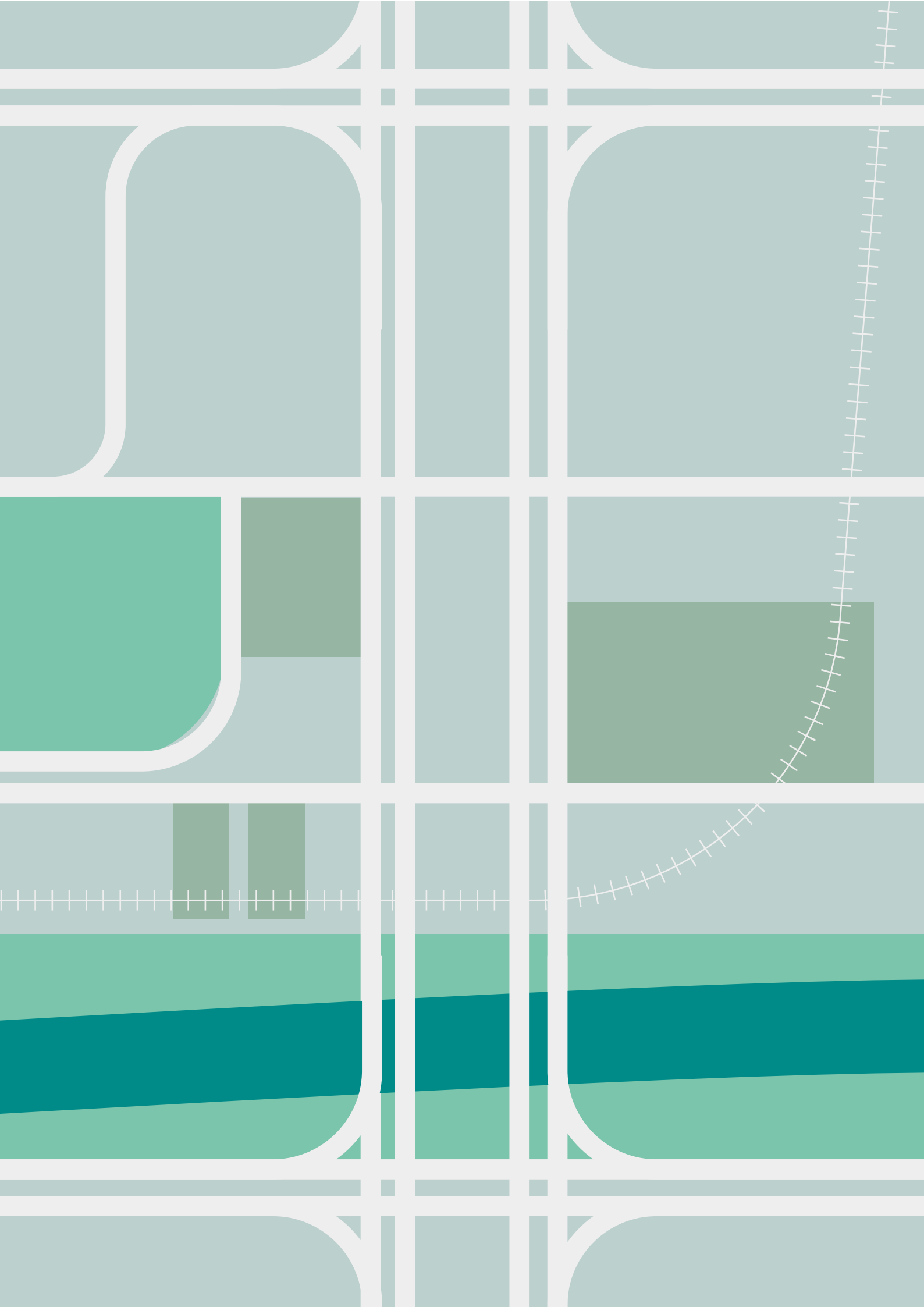

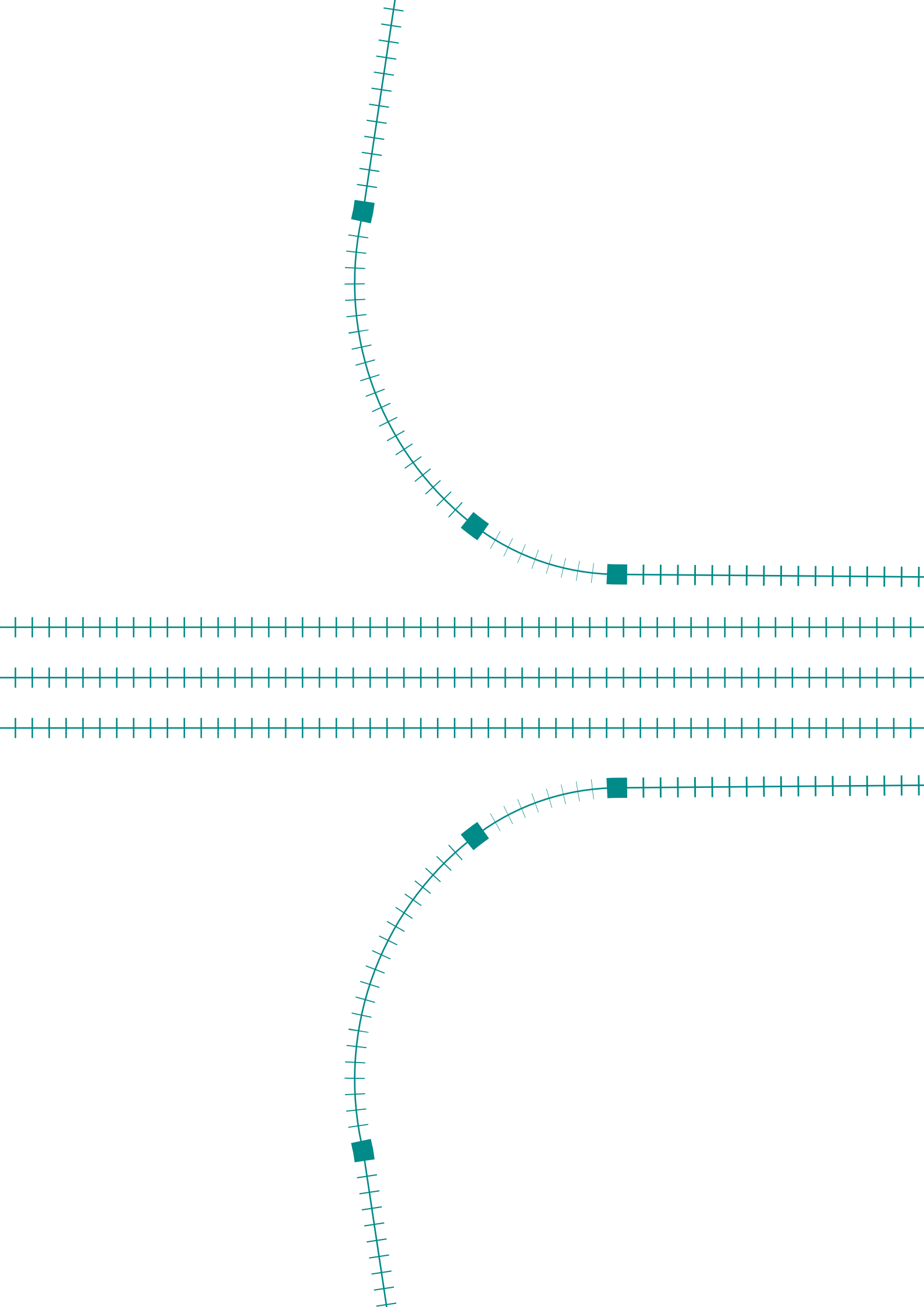

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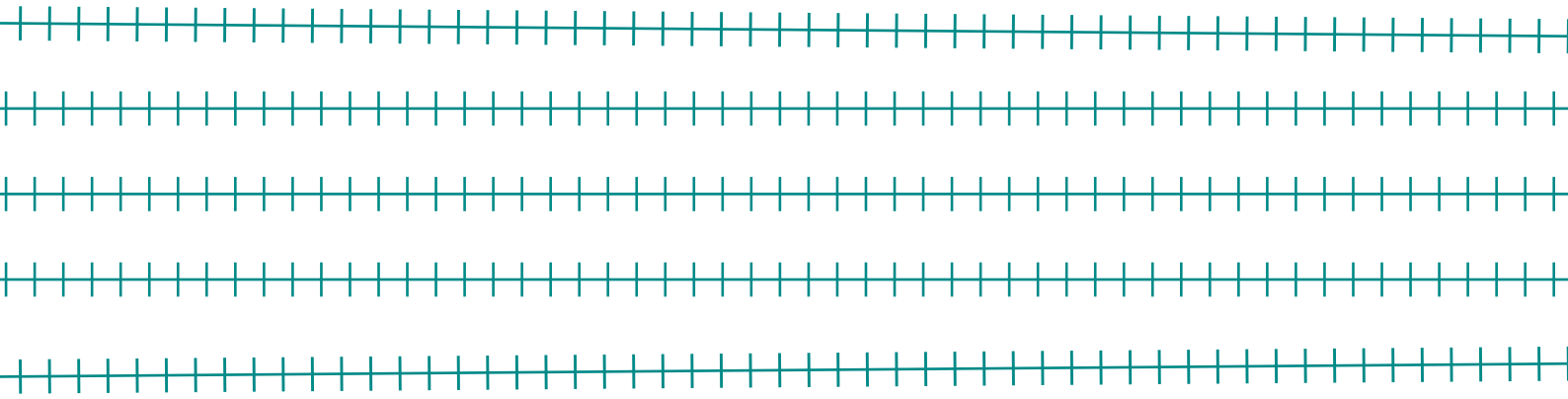

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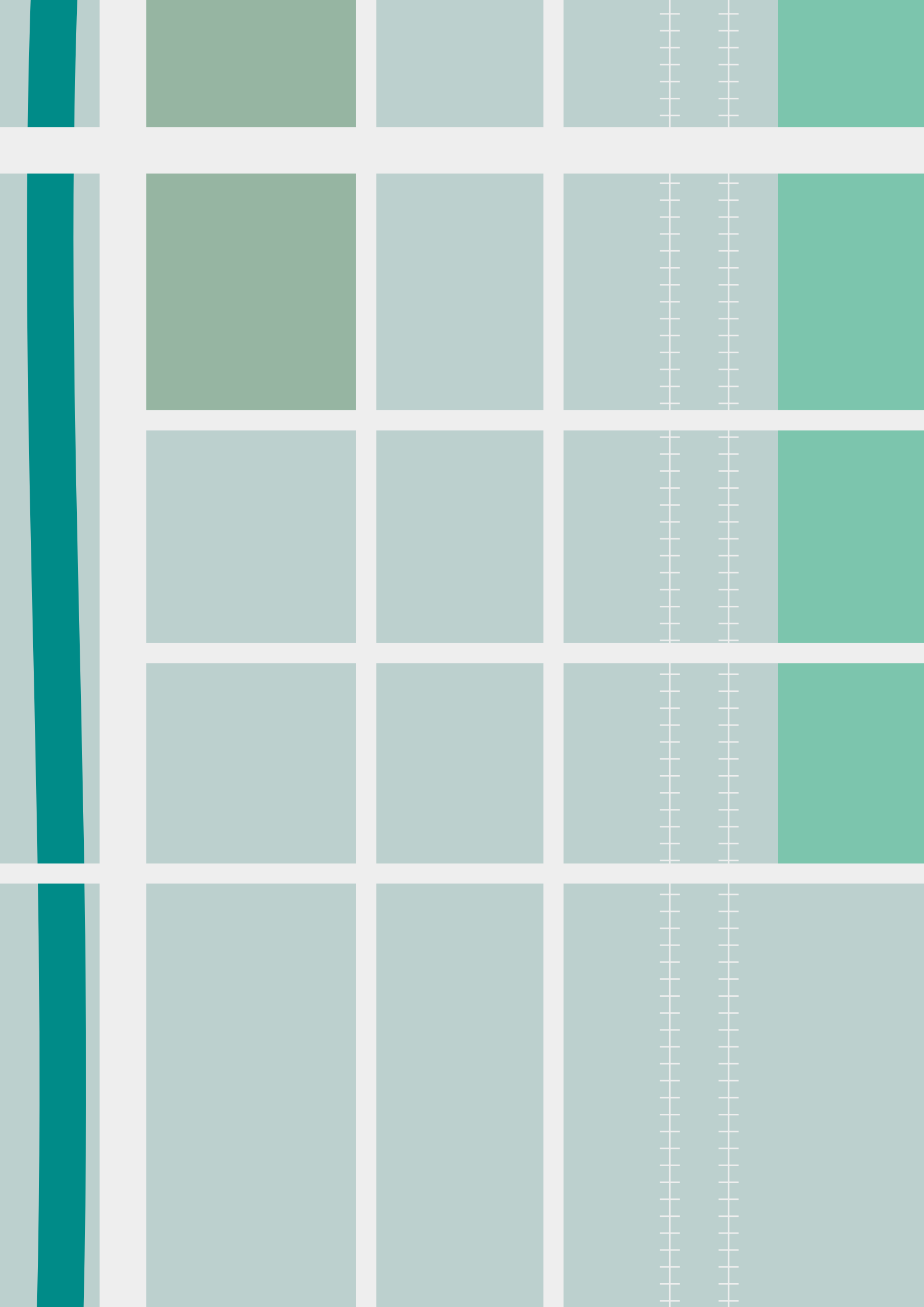
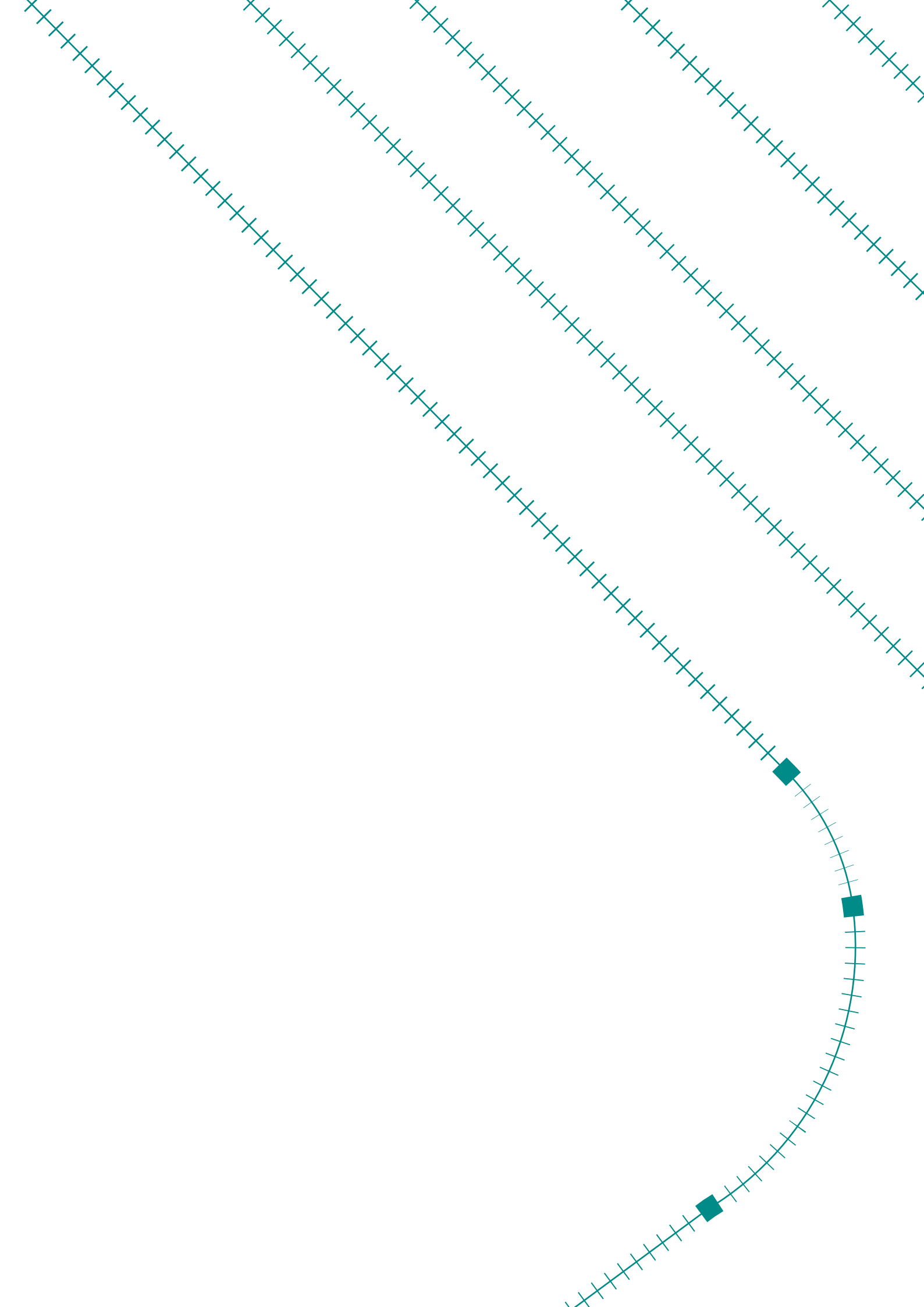
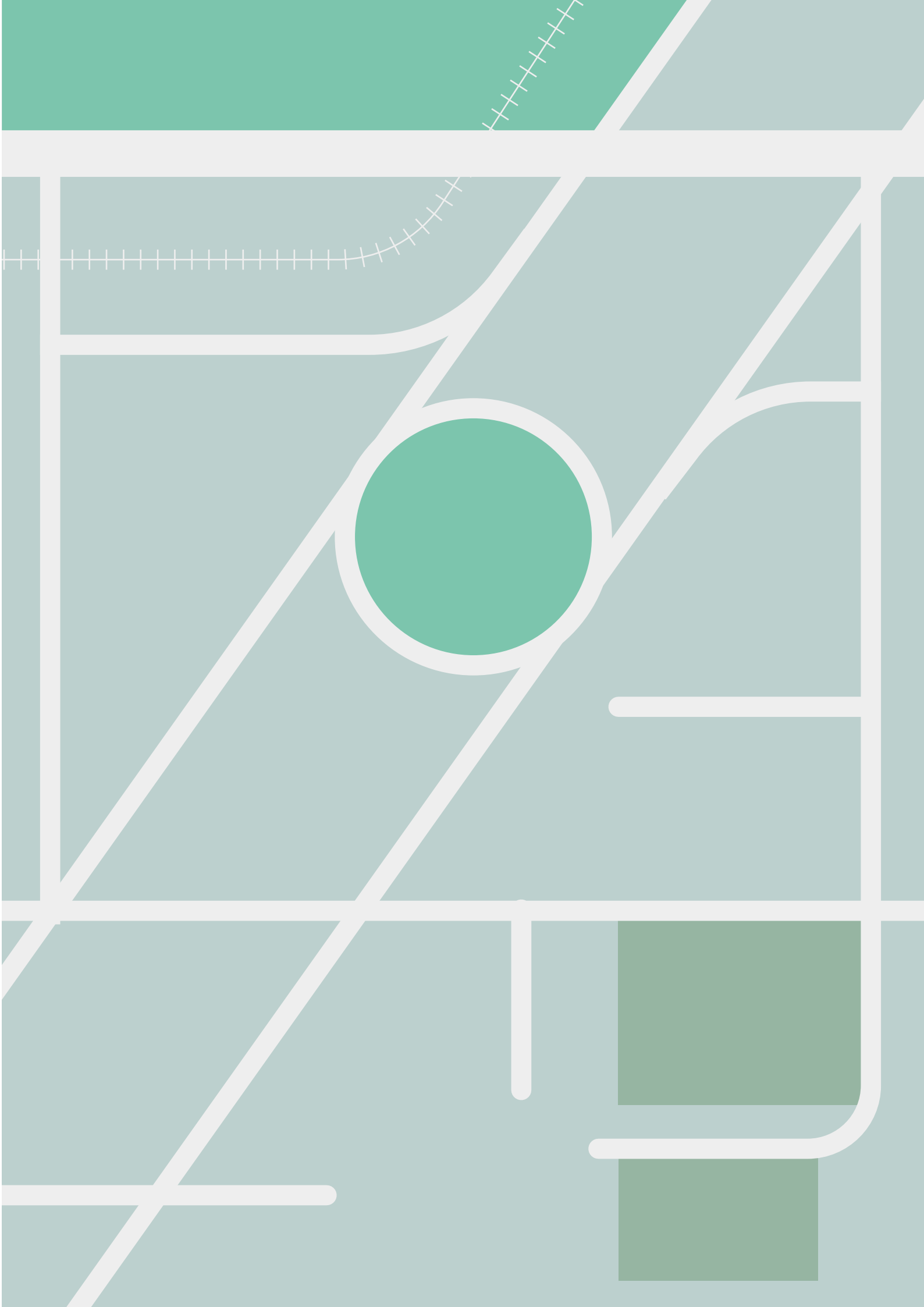


# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **BRT** | Bus Rapid Transit |
| **BNDES** | National Bank for Economic and Social Development (Banco Nacional de Desenvolvimento Econômico e Social) |
| **CCO** | Operations and Control Center (Centro de Operações e Controle) |
| **CET** | Traffic Engineering Company (Companhia de Engenharia de Tráfego) |
| **COP** | SPTrans Operations Center (Centro de Operações SPTrans) |
| **CPTM** | São Paulo Metropolitan Train Company (Companhia Paulista de Trens Metropolitanos) |
| **DOT** | Transport-Oriented Development (Desenvolvimento Orientado ao Transporte) |
| **EFOs** | Externally Financed Outputs |
| **EHIS** | Social Interest Housing Project (Empreendimento Habitacional de Interesse Social) |
| **EMTU** | São Paulo Metropolitan Urban Transport Company (Empresa Metropolitana de Transportes Urbanos) |
| **FGD** | Focus Group Discussion (Grupo Focal de Discussão) |
| **GDM** | Mobility Demand Management (Gestão de Demanda de Mobilidade) |
| **GHG** | Greenhouse Gas (Gases de Efeito Estufa) |
| **HIS** | Social Interest Housing (Habitação de Interesse Social) |
| **IBGE** | Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística) |
| **KPI** | Key Performance Indicator (Indicadores de Desempenho) |
| **LGBTQIA+** | Lesbian, gay, bisexual, transgender, queer, intersex, asexual + |
| **MaaS** | Mobility as a Service (Mobilidade como Serviço) |

| | |
|---|---|
| **Metrô** | São Paulo Metro Company (Companhia do Metropolitano de São Paulo) |
| **MSP** | Municipality of São Paulo (Município de São Paulo) |
| **OD** | Origin-Destination |
| **PITU** | Integrated Urban Transport Plan (Plano Integrado de Transportes Urbanos) |
| **PlanMob** | Municipal Urban Mobility Plan (Plano Municipal de Mobilidade Urbana) |
| **PMSP** | São Paulo City Hall (Prefeitura Municipal de São Paulo) |
| **PPP** | Public-Private Partnership (Parceria Público-Privada) |
| **RICE** | Reach, Impact, Confidence, and Effort |
| **RMSP** | Metropolitan Region of São Paulo (Região Metropolitana de São Paulo) |
| **SEHAB** | Municipal Housing Department (Secretaria Municipal de Habitação) |
| **SETRAM** | Executive Secretariat for Transport and Urban Mobility (Secretaria Executiva de Transportes e Mobilidade Urbana) |
| **SIGMA** | Mobility and Accessibility Georeferenced Information System (Sistema de Informações Georreferenciadas de Mobilidade e Acessibilidade) |
| **SMGO** | Operational Monitoring and Management System (Sistema de Monitoramento e GestãoOperacional) |
| **SMT** | Municipal Department of Mobility and Transportation (Secretaria de Mobilidade e Trânsito) |
| **SPObras** | São Paulo Obras |
| **SPTrans** | Sâo Paulo Transportes S/A |
| **STM** | Metropolitan Transport Department (Secretaria de Transportes Metropolitanos) |
| **SWOT** | Strengths, Weaknesses, Opportunities, and Threats |
| **UKPP** | United Kingdom Prosperity Program |





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The report is authored by a World Bank team led by the managers of the Smart Mobility Project: Carlos Bellas Lamas (transport specialist), and Taís Fonseca de Medeiros (transport specialist) and the following coauthors: Beatriz Moura dos Santos (specialist transport consultant), Eliana Pires de Souza (consultora especialista de acessibilidade), Gabriel Pereira Caldeira (specialist transport consultant), Luca Di Biase (specialist transport consultant), Maria Inês Garcia Lippe (lead transport consultant).

The work was conducted under the guidance of the directors Franz Dress-Gross (former regional director of infrastructure for Latin America and the Caribbean), Stephanie Gil (director of infrastructure for Latin America and the Caribbean), and Nicolas Peltier (global director of the Transport Global Practice), and of the program managers and leaders Maria Marcela Silva (transport practice manager, ILCT1), Eric Lancelot (lead transport specialist, ILCT1), and Luis Alberto Andrés (sector leader for water and infrastructure in Brazil, and lead economist), as well as by the World Bank Brazil country office directors Paloma Anós Casero and Johannes Zutt, and by the operations manager, Sophie Naudeau, who provided necessary support during the preparation and implementation of the program. Finally, we wish to thank Ana Waksberg Guerrini (senior transport economist) for her invaluable support during program implementation, Bianca Bianchi Alves (senior urban transport specialist) for her dedication as the first project manager, and Georges Darido Bianco (lead urban transport specialist). Many thanks also to the UK government team, including João Rampini, Gabriela Figueiredo, Adriana Figueiredo, and Adriana Alcântara, among others, for their support in the preparation and implementation of the program.

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1 Future Cities Program of the UK Government


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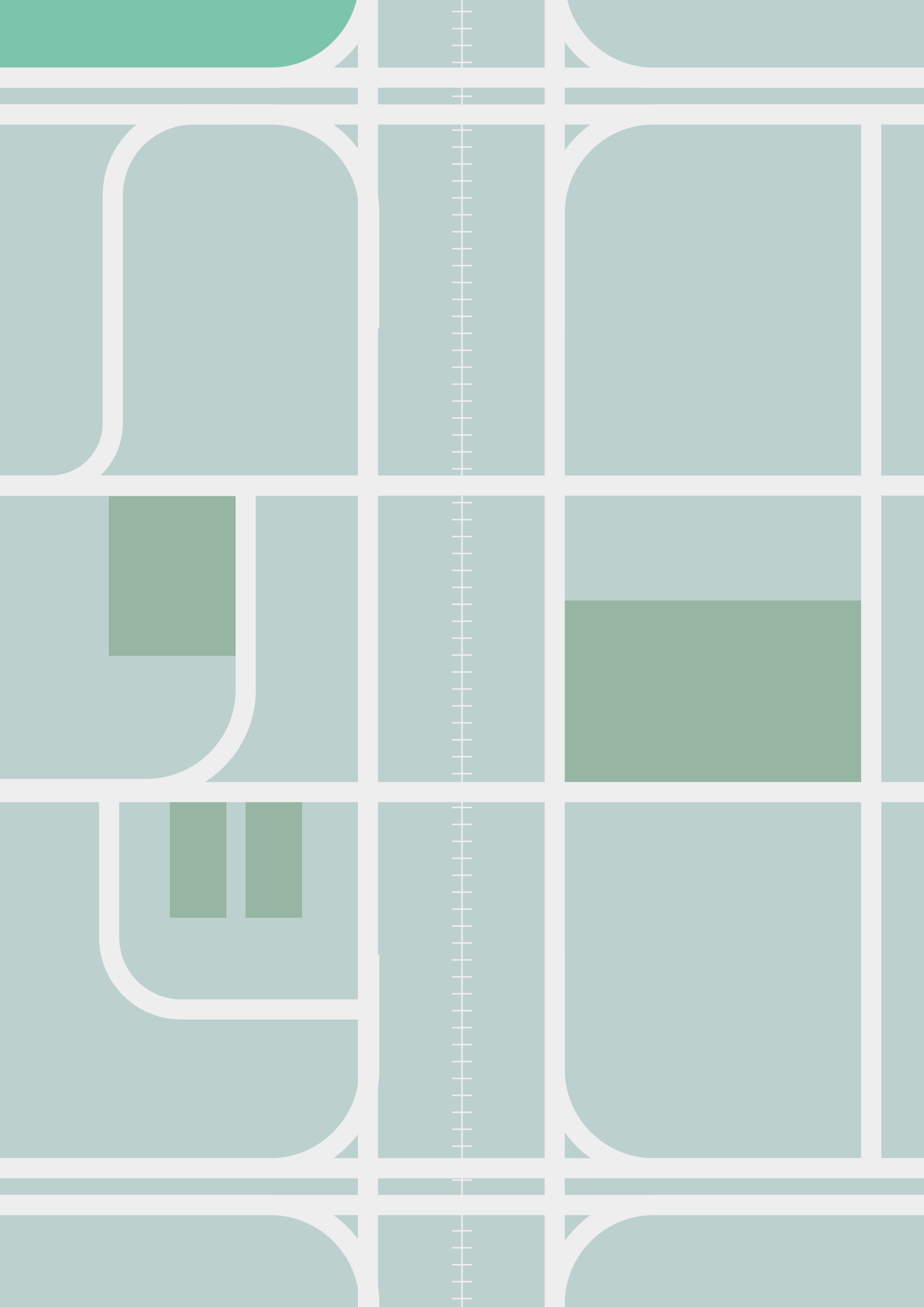


# EXECUTIVE SUMMARY



The Metropolitan Region of São Paulo (Região Metropolitana de São Paulo, RMSP) is the largest urban agglomeration in Latin America and one of the largest in the world, with a population of around 22 million, of which some 12 million live in the Municipality of São Paulo (Município de São Paulo, MSP). Despite being Brazil's richest city, representing 10 percent (R$763.8 billion)[2] of total gross domestic product (GDP), São Paulo is a city of great social contrasts. It was ranked in 2019 as the most unequal city in the country in terms of access to work, health, and education opportunities[3]. For example, the number of jobs accessible to the richest 10 percent of the population is nine times higher than the jobs available to the 40 percent poorest living in peripheral areas. São Paulo is also the most unequal city in terms of access to health care: the white population has twice as much access to high-complexity hospitals than the black population, partly explained by the socio-spatial distribution of income, job opportunities, and public services, as well as by the huge size of the city and coverage of the transport network.

Such numbers reflect the many immensely complex challenges involved in the design and implementation of inclusive programs, regardless of the area of activity. The current high-capacity rail mobility system has 15 lines (around 477 kilometers of track for subway and metropolitan trains) serving the RMSP. Meanwhile, SPTrans (São Paulo Transporte S/A) is responsible for running the municipal bus system with a fleet of approximately 14,000 vehicles. An additional 5,000 buses are operated by the São Paulo Metropolitan Urban Transport Company (Empresa Metropolitana de Transportes Urbanos, EMTU).

According to a 2017 Origin and Destination Survey (OD 2017), RMSP passengers make some 42 million trips per day. While public transport has relatively high coverage across the metropolitan region, the system lags behind increasing demand. The metropolitan region continues to face major challenges in terms of the number of private cars (two for every three families), increasing motorization in general, rapid urbanization, and the millions of commutes and long distances traveled daily.

Given the shortage of exclusive bus lanes and limited prioritization, buses compete for space on congested roads with single-occupancy vehicles. Around 60 percent of the road space in the MSP is taken by general traffic (mainly cars and motorcycles). This is 10 times more space than public transport (only 6.5 percent of the road space), and 20 times more if only the bus lanes are included (2.9 percent). Trips via public transport take an average of 67 minutes, more than double the average trip via private vehicle (31 minutes). This situation mainly penalizes lower-income people, with their

2 Brazilian Institute of Geography and Statistics (IBGE), 2019.

3 Research carried out by the Institute of Economic and Applied Research (IPEA) in 2019. Accessible in: http://repositorio.ipea.gov.br/bitstream/11058/9586/1/td_2535.pdf

lower mobility rates, longer travel times, and greater difficulty accessing urban goods and services. The limitations of the bus systemand slow expansion of the high-capacity rail network encourage even more widespread use of private vehicles.

The OD 2017 survey data reveal that of the 42 million daily trips taken in the RMSP, about 67 percent were via motorized modes (public and private) and 33 percent by nonmotorized modes (bicycle and on foot). Compared to 2007, there was a 10.3 percent increase in total daily trips in 2017. Travel by motorized modes increased by 12.4 percent, while travel via nonmotorized (hereafter called "active") modes increased 6.2 percent. Of total trips via motorized modes, those made in personal vehicles increased by 15 percent, while public transport trips (e.g., by bus) increased by 10 percent. As for active modes, bicycle trips grew by 24 percent and walking by 6 percent. Despite the increase in bicycle trips, these represent a mere 1 percent of total trips.

According to studies done in the City of São Paulo related to road space distribution, sidewalks take up 32 percent of road space, but when stretches that are unavailable for pedestrian use are accounted for (e.g., service lanes occupied by trees, lamp posts, etc.), as well as sidewalks narrower than the minimum 1.80 meters required to allow free movement, a mere 12 percent of São Paulo's roads include space suitable for walking, and only 9.2 percent are accessible to people with mobility restrictions. Physical barriers and safety issues affect women and the low-income population the most, who suffer from a lack of capillarity and connectivity between safe public transport options and the "active" mobility network.

The problems caused by this lack of infrastructure are made worse by insufficiently inclusive mobility policies that rely on limited data on the mobility needs of certain groups—people with disabilities, women (especially black and brown women), children, elderly persons, low-income people, and LGBTQIA+, among others. The needs of these groups are often not considered during the planning and implementation stages of the city's mobility and accessibility infrastructure.

Moreover, mobility planning, management, and operations still depend on the use of mainly analog tools, despite the opportunities presented by newer technologies. This leads to data being unavailable that could improve mobility systems, and allowing efficiency to lag the best global and regional practices. This is a key consideration for analysis under the Smart Mobility Program.

With the aim of supporting the City of São Paulo to progress toward a more efficient and inclusive transport system, the Smart Mobility Program was designed as a multiyear partnership between the World Bank and the United Kingdom's Future Cities Program in Brazil[4].

The main objective of the Smart Mobility Program is to promote integrated and sustainable transport systems in São Paulo to improve the quality of life of the most vulnerable inhabitants, reduce negative impacts on economic development, and combat climate change. **The core idea of the**

4 https://www.gov.uk/government/collections/cross-government-prosperity-fund-programmes

**initiative is that mobility and urban accessibility in São Paulo can be improved in a smart and innovative way, including through technological development, to promote economic efficiency, environmental sustainability, and social equity.**

The governance and planning of mobility and, more generally, of the city's development, need to focus on those who most need access to opportunities. Experts and practitioners involved in this initiative agree that **mobility is only smart if it takes into account the different views and concerns of the people who live in a city**, and conclude that a genuine innovative breakthrough would be to produce a city for everyone.

The Smart Mobility Program for the City of São Paulo—P173414 (hereafter referred to as the "Smart Mobility Program" or simply the "Program"), is one of the largest technical analysis and consultancy projects ever implemented by the World Bank in a single city. The Program was conceived to provide support to the São Paulo City Hall (Prefeitura Municipal de São Paulo, PMSP) to create a multidisciplinary strategic reference benchmark to improve **the management and planning of mobility and urban accessibility** in the City of São Paulo (and therefore a better quality of life for its citizens—especially the most vulnerable) through the deployment of **inclusive policies, technological innovations, and smart planning.**

The Program contained 8 different groups of activities, with a total of 17 studies, conceptually organized around 2 main pillars:

1. **Create a more integrated and efficient transport planning and management process aimed at recovering demand for public transport and reducing emissions.** The activities included proposals for using methodologies and tools for evidence-based decision-making, including planning and managing bus systems and bus corridors with new models of operation/prioritization, regulating metropolitan governance for the integration of MaaS (Mobility as a Service),[5] and upgrading traffic lights using 5G technologies.

2. **Improve the regulatory and policy framework governing transport in the PMSP with the aim of providing more inclusive urban mobility services for women and people in socioeconomically vulnerable situations**. Recommendations, training materials, and methodologies highlighted the unique challenges faced by these groups in accessing jobs and other services. The activities also included discussions on policies to promote sustainable modes of transport, such as cycling and walking.

5 Mobility as a Service describes a shift from personal ownership of the means of transport to mobility solutions that are consumed as a service, in an integrated and connected way. The main paradigm shift is that MaaS puts the passenger at the center of attention, offering a better service and experience in a personalized and integrated way.

The activities carried out under Pillar 1 were as follows:

i. **Activity 1. Support for the new Operations Center ( Centro Operacional - COP) for SPTrans—integrating artificial intelligence, big data, and mobility as a service (MaaS) in the planning and operations of public transport by bus.** Activity 1 aimed to identify innovative alternatives that could be applied to operations control centers (Centros de Operações e Controle, CCOs) and operational management and monitoring systems (Sistemas de Monitoramento e Gestão Operacional, SMGOs) with a view to optimizing transportation planning, and operations, and supporting the deployment of the MaaS concept. SPTrans' active involvement produced tailor-made recommendations, which increased the likelihood of them being implemented. The activity was also a learning opportunity, highlighting best practices from cities where big data analytics and machine learning processes have been successfully integrated into transportation planning and daily operations to support local MaaS platforms.

ii. **Activity 2.1. Microsimulation of mobility along the new Aricanduva BRT Corridor.** The microsimulation of the new BRT (bus rapid transit) corridor along Avenida Aricanduva, financed with World Bank resources, has produced a new methodology to evaluate the performance benefits of various traffic flow models of private vehicles and public transport along the corridor. As a result, the Traffic Engineering Company (Companhia de Engenharia de Tráfego, CET) adopted simulation tools to aid the analysis of transport projects and to support decisions on layout changes and technological alternatives for traffic control.

iii. **Activity 2.2. Evaluation, characterization, and scoping of the most promising technological alternatives for smart traffic lights and 5G telecommunications technology**. The objective of this activity was to carry out a case study analysis in São Paulo to address existing and future challenges related to the digitization of traffic lights, sustainable traffic management, prioritization of public transport, and active modes. The activity also aimed to analyze the potential of 5G technology in the development of smart transport services and systems.

iv. **Activity 3. Analysis and recommendations for the establishment of a municipal governance scheme in São Paulo centered on implementing a MaaS model.** This activity aimed to pave the way for the implementation of the MaaS concept at the municipal level, including by assessing the governance and public policies needed to create an integrated transport system across all areas of operation: physical, tariffs, technological, operational, and institutional. As a result of this activity, the MSP received a structured reference with guidelines to: (1) provide information on the overall mobility process; (2) review and improve the corporate organization for full MaaS governance; and (3) monitor the action plan, together with a preliminary suggestion to develop and implement a checklist of tasks.

v. **Activity 4. A study proposing a methodology for prioritization of exclusive bus lanes in the City of São Paulo, including maintenance and operation.** This study aimed to support the PMSP to establish criteria for prioritizing and identifying the investments required to implement the city's bus corridors program. The bus corridor assessment focused on: (1) updating the infrastructure classification method to include demand and operational scope as well as physical attributes; (2) establishing a workable evaluation method based on finding an appropriate balance among, for example, physical, operational, and demand dimensions directing functions to meet real needs; and (3) deploying an action plan and prioritization method to show how the new methodology is applied (in this case, a pilot scheme to modernize the present bus lanes).

In Pillar 2, the following activities were carried out:

i. **Activity 5.1. Transport for all—gender and race in urban mobility.** The study aimed to contribute to the awareness, training, and improvement of the public authorities responsible for planning the public transport system in the City of São Paulo and its Metropolitan Region, with a view to reducing gender and racial inequalities in the context of urban mobility.. This activity therefore focused on (1) identifying women's transport needs; (2) preparing awareness training for transport decision-makers; (3) recommending the creation of an unique protocol for reporting cases of harassment and abuse in transportation; and (4) highlighting the need to increase women's participation in transport corporations and identifying the barriers to this.

ii. **Activity 5.2. Mapping safety and accessibility around the Aricanduva BRT Corridor.** This activity provided recommendations to improve the local infrastructure around the future corridor in order to improve accessibility and improve safety perceptions among women and people with disabilities. The recommendations are in line with issues of inclusion identified in the security and accessibility mapping activities, collecting data on key variables affecting safety (e.g., lighting, walkways, visibility, frequency of public transport, conditions at bus stops, gender issues, and people's own views).

iii. **Activity 5.3. Indicators of gender inclusion and the accessibility of bus terminals in the City of São Paulo.** The study aimed to (1) define an audit and analysis protocol, replicable across terminals, for analyzing and ensuring the inclusion of interest groups; and (2) develop indicators to identify baselines and record the impact of improvements and investments made over time.

iv. **Activity 6.1. Urban logistics—use of curbs and alternative modes for efficient freight delivery in São Paulo.** This activity addressed this phenomenon on three fronts: (1) an analysis of using curbside deliveries; (2) how to expand the use of sustainable delivery

modes through cyclologistics; and (3) the possibility of changing legislation to increase the efficiency of urban freight transport. The results highlighted the potential for freight-carrying bikes and crossdocking points.[6] A manual was also prepared containing guidelines for implementing cyclologistics pilot schemes in the city that could be used by the PMSP and interested companies going forward, along the lines of the pilot model tested in Bogotá (Colombia).

v. **Activity 6.2. Analysis of shared space in the City of São Paulo.** The study aimed to analyze the distribution of the current road system in the MSP by studying the different modes of transport. The main idea was to establish a mobility demand management (MDM) strategy to promote greater equity in the use of available space and, by so doing, promote active and public transport while spurring disincentives to the use of individual motor vehicles. Policies were recommended for MDM that were more focused on active mobility, including a sidewalk action plan. Finally, attention was paid to best global practice policy recommendations endorsing more equitable use of road space for various mobility modes.

vi. **Activity 6.3. Microaccessibility Manual.** This activity aimed to provide technical support to PMSP in the design of urban interventions to improve the city's walkability and accessibility conditions. The Microaccessibility Manual (Biblioteca de Microacessibilidade) developed in this study contains practical solutions for the urban environment aimed at the inclusion of all people in the public space by promoting greater security, autonomy, freedom, pride, and representation.

vii. **Activity 6.4. Support planning bike lanes in São Paulo.** This study aimed to provide technical support to PMSP to assist its analysis of barriers to bicycle use in the urban space. This analysis involved collecting data on cyclists and recommendations to support decision-making on establishing priorities for expanding the bike lane network, developing and implementing new bike lanes, improving existing connections, meeting current demand, and attracting new bicycle users. It also makes recommendations on the design of bike lane infrastructure and the expansion of the shared bicycle and bike parking system in the MSP. The activity helped to better understand the impact of the MSP's public policy (BikeSP)[7] on the demand for cycling, as well as shedding light on citizens' views on the workability of the policy. The social cost-benefit analysis also provided evidence to the MSP on the impacts of investments in cycling infrastructure.

viii. **Activity 6.5. Safe and accessible school routes for children.** This activity aimed to complement the third phase of the "Safe School Route in Peripheral Regions of the PMSP Program" designed to improve accessibility conditions for all children traveling

6 Crossdocking is defined as a distribution method in which the goods received in a warehouse or distribution center are not stored (as would have been common practice until recently), but are instead prepared for loading and distribution or dispatch to the customer or consumer immediately, or as soon as possible.

7 Available at: <http://documentacao.camara.sp.gov.br/iah/fulltext/leis/L16547.pdf>

to and from school. The study involved the collection and use of data to identify needs and opportunities for improving accessibility for the most vulnerable populations such as children, caregivers, and low-income families. This process generated key information for workshop discussions and project follow-up promoting the active involvement of local communities to improve access to school for children and their caregivers.

ix. **Activities 7.1 and 7.2 Analysis of mobility barriers in the catchment area of the BRT Aricanduva, and a baseline survey of the Aricanduva BRT project.** This activity focused on the inclusion of minorities in the transport system, providing inputs for the oversight of the Aricanduva BRT project implementation, and contributing to an understanding of the reasons for the low mobility of the low-income population living in the corridor's "catchment" area (area of influence), which includes around 29,000 families living in favelas. The study sought to identify the barriers impeding the use of public transport by the low-income population: physical barriers such as restricted or difficult access to bus stops; economic barriers such as high bus fares; or social barriers such as fear of harassment. In addition to this analysis, data collection was carried out employing face-to-face surveys once the necessary sanitary conditions related to COVID-19 prevention had been met. Approximately 5,000 households were surveyed. The conclusion was that this approach will play an important role in any future assessment of the impact of the Aricanduva BRT on people's lives, by comparing trip time gains and cost reductions with the control area chosen in the south of the city.

x. **Activity 7.3. Use of real estate for social interest housing (HIS),** developed a model for the maximum use of the expropriated areas by proposing the building of social interest housing (Habitacional de Interesse Social, HIS)[8] next to the new subway stations of the São Paulo Metro Company (Companhia do Metropolitano de São Paulo, Metrô). This model was employed as the starting point for a social housing development on land expropriated for the construction site of the future Aricanduva metro station. At the same time an analysis was carried out of existing incentives, in the light of current legislation, for this type of project, and the benefits of the new approach to the resettlement problem. The same model could be used by Metrô and PMSP in future public transport projects in the city and the RMSP.

xi. **Activity 8. Opinion survey on mobility in the City of São Paulo.** To provide evidence for improving the communication between PMSP and the population, and to contribute to the preparation of a Mobility Communication Plan, the survey focused on mapping public opinion on future mobility challenges and the use of urban space, particularly in the light of post–COVID-19 pandemic measures, based on new technologies to benefit public and active transport modes. The results clearly showed the

8 HIS is a residential unit of up to 70 square meters with one bathroom and a parking space for families with a monthly income of up to six minimum wages.

importance of focusing on good communication with the public when planning mobility policies as a way of involving them, providing opportunities for authorities to listen to their concerns, and encouraging cooperation with the agencies involved.

The Program's thematic scope represents an important contribution to the studies regarding the Aricanduva BRT and SPTrans Operation Center (COP), both of which are currently benefiting from works and equipment financing through a loan from the World Bank (P169140)[9].

The execution of these activities increased PMSP teams' technical knowledge and encouraged inclusive and efficient approaches to transport including:

i. **The "city designed for the citizen"—a deeper look at gender, race, and accessibility of the most vulnerable segments of the population,** defining infrastructure from a human viewpoint, considering the creation of bus lanes that take into account accessibility to bus stations and terminals, for example, as well as taking a more in-depth look at the CET, which needs to improve access to some of its initiatives such as the Municipal Safe School Routes Program and the Microaccessibility Library.

ii. **The evolution of a technological mobility ecosystem, focusing on the integration of SPTrans IT systems and the traffic light network,** which together with the analysis of governance for MaaS and the reorganization of the databases on bus corridors, aim to improve the quality and efficiency of bus services. All this would make it possible to move toward the use of cutting-edge technologies such as artificial intelligence and big data, and further physical integration and better cooperation with other essential services involved in the operation of the transport system (CET, metro, São Paulo Metropolitan Trains Company [CPTM], police, fire department, mobile emergency medical services [SAMU], etc.).

iii. **A broad approach to the development, management, and financing of the bus corridors,** including their urban surroundings and the avenues along which corridors are to be implemented, and efforts to improve accessibility to bus users, define methodologies to enhance the operation and maintenance of corridor infrastructure, and apply recommendations for the establishment of proactive pavement maintenance contracts.

iv. **Democratization of road space and promotion of sustainable mobility,** by using road space in a more equitable way, encouraging the most efficient and sus-

9 Available at: <https://projects.worldbank.org/en/projects-operations/project-detail/P169140>

tainable routes compatible with existing corridors—initiatives that should enhance the attractiveness of public and active mobility and favor a major shift to public transport by current users of individual motorized vehicles.

v. **Better forms of management of smart traffic lights to prioritize public and active mobility modes** by introducing models to ensure more efficient and less congested intersections compared with the current system that gives priority to motorized transport.

vi. **Governance policies and regulations for the implementation of MaaS,** scoping the objectives of all stakeholders, and gradually consolidating the proposal for an integrated conceptual governance model based on international benchmarking analyses.

Finally, given the need to implement the Program based on the recommendations of each activity, next steps would include:

i. Contracting studies and training programs for the deployment of activities;

ii. PMSP to develop management and communication systems;

iii. Economic-financial modeling, and a business model, designed for deploying bus corridors, efficient systems, inclusive plans, and the necessary infrastructure;

iv. Preparation of a budget forecast for the implementation of activities;

v. Preparation and launch of bidding documents for investments in infrastructure and systems; and

vi. Structuring and financing of the Program as a whole.

These steps highlight the need to produce well-researched studies and prepare stakeholders for their involvement in the Smart Cities Program. Clearly there is a need to hire consulting services to detail certain actions of the Program and train the teams involved:

i. Strategy for traffic light modernization;

ii. Accelerate progress on integrated transport proposals;

iii. Further develop the new MaaS-related ticketing model;

iv. Integrate mobility and HIS;

v. Set up a training program on inclusion in transport;

vi. Plan and operationalize new urban logistics;

vii. Develop management and communication systems;

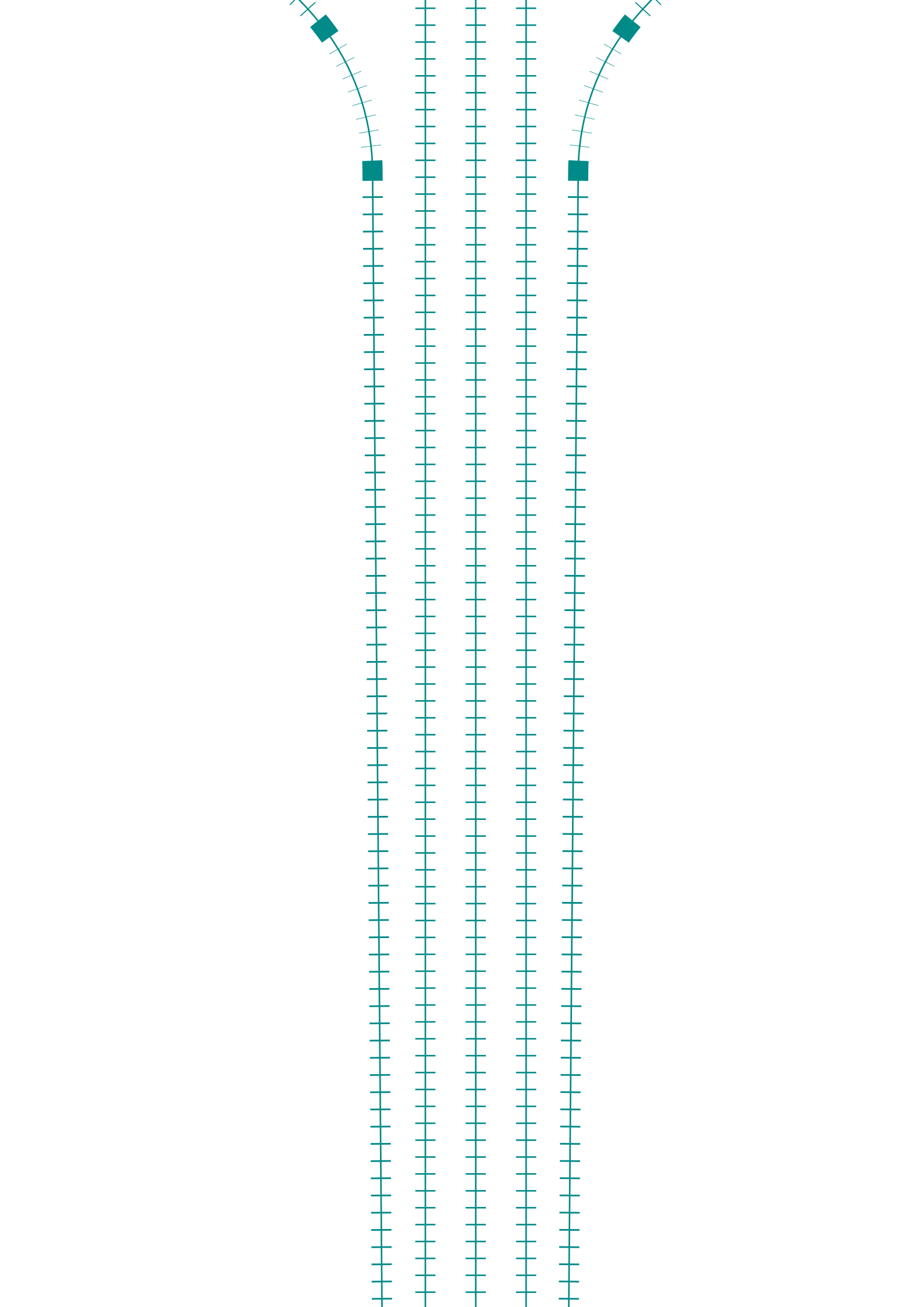
viii. Develop and implement SIGMA;

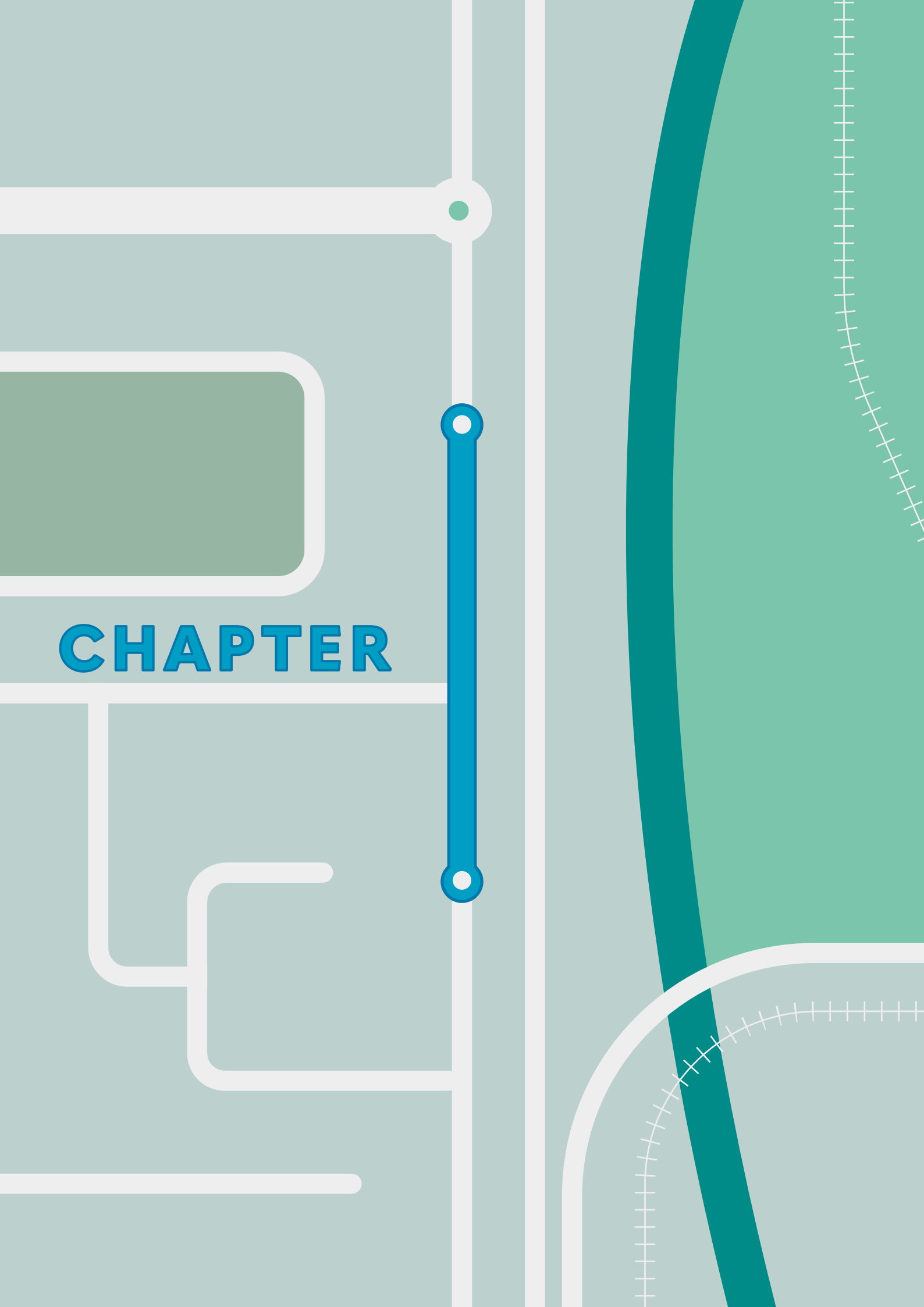
ix. Develop and implement the SMGO and Data Lake; and

x. Establish a permanent procedure for conducting surveys on people's perceptions of mobility systems.

Finally, the general recommendations suggest the creation of a Project Management Unit, with teams to detail and administer projects, implement the proposed interventions, and monitor the results. The recommendations also include examining the potential for a participatory process and communication channels to encourage collaboration between institutions, and select the appropriate management tools for the Program.

This report highlights the development of Program activities and recommendations for São Paulo, which may also be of interest to other cities throughout the world.




CHAPTER

# 1 | THE SMART MOBILITY PROGRAM IN SÃO PAULO, BRAZIL

The World Bank has a long-standing commitment to urban mobility, alongside the authorities of the City of São Paulo. This commitment includes loan operations and technical assistance. Ongoing and past projects include support for the development of regulatory frameworks and innovation centers (e.g., MobiLab), infrastructure projects, including the Luz station; Metro lines 2, 4, and 5; transportation planning and long-term mobility in the Metropolitan Region of São Paulo (e.g., the Integrated Urban Transport Plan [Plano Integrado de Transportes Urbanos, PITU 2040]); the first phase for the structuring of the intermunicipal train public-private partnership; and support for the concession of lines 8 and 9 of the São Paulo Metropolitan Train Company (Companhia Paulista de Trens Metropolitanos), and for the construction of the Aricanduva BRT (bus rapid transit) Corridor, among others. The World Bank also completed a Sustainable Transport and Air Quality Program with funds from the Global Environment Facility, and is currently working on an electric mobility technical advisory for Brazilian cities, focusing on the potential use of electric buses. Finally, in terms of road safety, the World Bank, together with the Bloomberg Initiative, has spent more than a decade working on various safety initiatives with the São Paulo City Hall (Prefeitura Municipal de São Paulo, PMSP), especially with the Traffic Engineering Company (Companhia de Engenharia de Tráfego).

Given this history of collaboration with local authorities, the World Bank was contracted by the UK government to manage the resources of a grant from the UK Prosperity Program, and to be responsible for assisting the identification of studies relevant to the topic of smart cities, as well as for hiring consultants, consortia, or independent specialists for developing technical advisory services. The focus of the Smart Mobility Program (hereafter sometimes referred to as simply the "Program") is to identify innovative activities and technologies for improving mobility and accessibil-

ity, traffic flows, urban transport management, and strategic planning, with a view to improving the quality of life of the city's population, especially the most vulnerable sectors.

The aforementioned grant was committed in two phases: the first phase, equivalent to 10 percent of the total amount, was of a preparatory nature; and the second phase, as described in this report, focused in greater detail on the studies and activities for consolidating the Program.

The first phase, in the shape of an externally financed output (EFO), was developed from September 2018 to December 2019, and the second from early 2020 to March 2022 (during the COVID-19 pandemic). The reports and activities were published in January 2023.

The EFO activities were planned to support the second phase of the Program with the ultimate objective of boosting the development of a smarter, cleaner, safer, and better São Paulo for everyone, by using planning resources and urban and computer technology more efficiently to provide solutions to the challenges in the mobility area. This first part of the Program addressed problems including: (1) traffic congestion and road safety, with the introduction of smart traffic lights and public transport prioritization; (2) more efficient public transport management with control platforms enabling an adequate level of planning and operations for the city as a whole; (3) better management of bus lanes, prioritizing those with a more beneficial cost-benefit ratio; (4) a safer environment for women who use the city's transport systems; and (5) the promotion of innovation as a key component in public sector contracts.

The activities carried out during the first phase contributed to understanding and designing new concepts of smart traffic lights that give priority to pedestrians, cyclists, and public transport users, and that are vital for bus lane planning, bus and traffic control, and management systems (creating potential for data management open to third parties). The smart traffic lights concepts were successively specified and detailed in the Program's second phase.

Between the two phases of the Program, there was a technical visit to London in November 2019, coordinated by Transport for London (TfL). This included a presentation of TfL good transport practices and experiences to a group of officials from the UK government, the World Bank, and members and technical staff from the Municipality of São Paulo and the Government of the State of São Paulo. This visit pointed to the need for all municipal transport schemes to stay closely aligned with the metropolitan networks.

The second phase, implemented as a trust fund, was developed in accordance with the World Bank Country Partnership Framework, signed with Brazil for FY18–FY23 (Report No. 113259-BR, of May 16, 2017), aimed at focusing on "Inclusive and sustainable development" with the objective of "Providing more inclusive and sustainable urban services," reflecting the need to improve efficiency and introduce new models of urban service delivery to improve the population's quality of life.

This report describes the activities implemented in the second extensively detailed phase of the

Program based on the EFO conclusions. Program preparation involved organizing numerous workshops and training courses, all of which contributed to consolidating bases for innovation and the creation of a multisectoral approach to transport problems through the development of governance and planning practices designed to incorporate appropriate technology and implement new business models.

In addition to exploring more deeply the topics covered in the EFO, the Smart Mobility Program broadened its analytical scope to include studies on (1) accessibility; (2) active mobility and other nonmotorized modes of transport; (3) regulations for shared road space, low-emission zones, and efficient urban freight mobility; and (4) improved governance and coordination of the transport sector by the main stakeholders in the Metropolitan Region of São Paulo.

A total of 17 studies were carried out in Phase 2 through 9 international tenders and other supplementary hirings of specialist consultants. All the activities were preidentified after substantial stakeholder consultation at the EFO phase and in a joint workshop with counterparts of the UK Prosperity Program. Annex 1 of this report contains a list of the final technical documents linked to each of the 17 activities (documents published by the World Bank and those shared with the PMSP for internal use).

The wide-ranging and productive discussions between the World Bank and the Municipality of São Paulo's secretariats and transport companies resulted in a series of contracts tailored to the PMSP's requirements.

Notwithstanding the size and complexity of the output generated by the Program, this final report seeks to consolidate its results in a single document. It is hoped that the report, describing the components and expected impacts of the Program, will become a strategic reference guide not only for implementing the Smart Mobility Program in the City of São Paulo, but also as a technical reference document for developing similar programs in other Brazilian cities and further afield.


CHAPTER
7

# 2 | MOBILITY IN SÃO PAULO

## 2.1 | BRAZILIAN CONTEXT

With around 183 million people living in urban areas (87 percent of the total population), of which 106 million live in 59 cities with more than 300,000 inhabitants, Brazil has a growing need to improve urban planning processes and systems by systematically incorporating technologies to improve mobility efficiency, using advanced data analysis tools (big data and artificial intelligence) and other technical innovations that can make a city smart, egalitarian, and sustainable.

For many years Brazilian cities were global models of urban transport management. As one of the world's most heavily urbanized countries, Brazil had some success in developing innovative solutions to public transport issues. One of the main solutions implemented, for example, was the bus rapid transit which, after being launched in the city of Curitiba in the 1970s, spread throughout Latin America and other parts of the world, often with World Bank financing.

However, in recent decades this process of mobility innovation, which played a fundamental role in developing favorable cost-benefit solutions, has slowed down significantly. While investments in urban transport declined substantially, economic policies implemented at the national level have led to an increase in the numbers of individual motor vehicles. Over 15 years the motorization rate almost doubled in Brazil, from 23.9 vehicles per 100 inhabitants in 2008 to 52.3 vehicles per 100 in 2021. The ever-increasing number of road vehicles over recent decades in fact reflects policies adopted since the automobile industry took root in Brazil in the 1950s, combined with the rapid urbanization and outward expansion of the cities. Meanwhile, federal, state, and municipal urban transport policies have favored automobile manufacturing and use, forcing the building of major expressways, bridges, and viaducts, and the adoption of traffic engineering focused on vehicle flows.

From the 1950s to the 1970s, large internal migration movements attracted by industrial jobs led to rapid population expansion in cities. Many urban residents were pushed out of the main urban centers toward peri-urban areas at the peripheries of cities due to virtually unstoppable demographic pressure. This process resulted in the proliferation of "dormitory" areas increasingly distant from the main centers and subcenters of employment. The skewed development pattern of Brazilian cities, together with budgetary constraints, caused a mismatch between urban demands and the provision of infrastructure and transport services, generating a series of urban diseconomies and an unbalanced distribution of access to opportunities.

With limited user prioritization in the road system, buses competed for space on congested roads with individual vehicles. In 1997, trips made via public transport were on average 2.3 times longer and 2 times more expensive than trips made in private vehicles. This situation penalized mainly lower-income people with a lower rate of mobility, longer hours away from home, and greater difficulty accessing urban goods and services. The supply limits of public road transport and the slow expansion of the high-capacity rail network encouraged the ever-increasing use of private vehicles.

Closing this vicious circle, in which congestion makes public transport less and less attractive, is only possible with policies to boost public transport and active mobility. A different approach to public investment policies and transport management and operation policies is a fundamental requirement for combating negative externalities and enabling agglomeration economies to thrive in Brazil.

Five Brazilian cities are among the 100 most congested in the world[10]. Recife occupies position number 24, while Rio de Janeiro and São Paulo are in the 39th and 68th position, respectively. Origin-destination (OD 2017) survey data reveal that commutes to work in the region average 31 minutes for users of individual motorized modes, and 65 minutes for public transport users. Moreover, 41 percent of trips by public transport take more than one hour, while only 5.9 percent of individual motorized trips are longer than one hour.

Low-income families make up the vast majority of public transport users and are obviously the most affected by the transport system's low performance. This fuels inequality. It is estimated that in Brazilian cities twice as many workers in the 10 percent lowest-income bracket spend over one hour traveling from home to work compared to the richest 10 percent of the population, and spend an average of 20 percent more time commuting than the higher-income group.

A further important point—women, particularly black women, suffer most from the lack of quality transport services due to the spatial segregation of poorer population groups and women's greater dependency on public transport (even when a family has a private vehicle it is generally used by men). Decades of discrimination and low participation in decision-making have held back the development of transport services to suit the needs of these population segments. The only options presented to women for trips to work or to carry out the care activities (accompanying children to school, etc.) for which they are almost always solely responsible, are slow and crowded vehicles, a situation that exposes them to a high

10 Traffic Index 2021. TomTom. Available at: <https://www.tomtom.com/en_gb/traffic-index/ranking/>

risk of sexual harassment. In these circumstances it is easy to understand how public transport is generally avoided by women—a considerable segment of the population—whenever possible. Figure 1 shows the low accessibility experienced particularly by black women in the RMSP's high- and medium-capacity public transport networks as an example of the barriers that women need to face.

Low investment and lack of coordination and integration of transport policies are among the main challenges facing urban mobility in Brazilian cities. The negative externalities mentioned above stem from a long-standing shortage of urban infrastructure resources (especially in public transport) and the failure to integrate land use and occupation with transport policies. The combination of a lack of investment and insufficient land use/transport policies created a spatial mismatch between jobs and housing, leading to increased motorization and low population density in large urban areas during a period of high economic growth (2004–10).

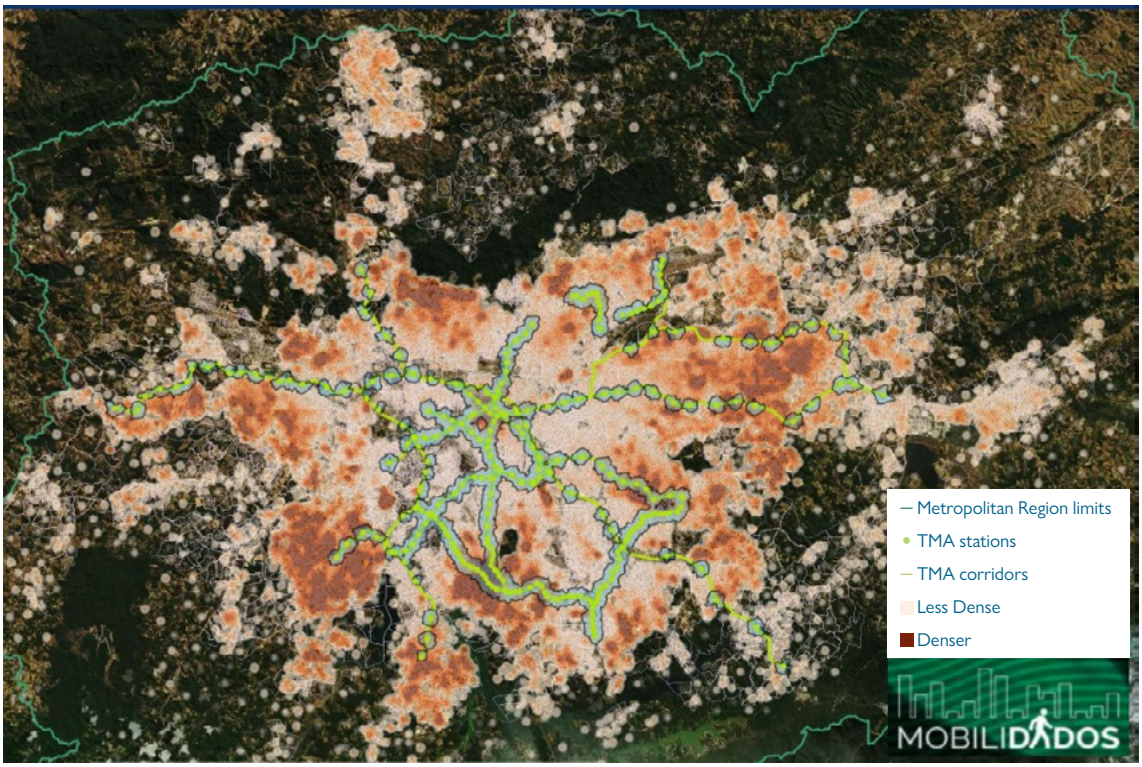



**Figure 1 | Spatial distribution of brown and black women in the RMSP and a one-km buffer of the main mass transit lines – Metro and CPTM. Source: ITDP (2022).**

Note: CPTM = São Paulo Metropolitan Trains Company; km = kilometer; RMSP = Metropolitan Region of São Paulo.

In the past 15 years, the number of public transport users in Brazil fell by 15 percent (Figure 2) while the country's car fleet almost doubled, and its motorcycle fleet expanded fivefold. In 2019, public spending on individual motorized vehicles was four times higher than on public transport in 2014. In 2015, the National Bank for Economic and Social Development (BNDES) estimated that

R$235 billion was needed to fill the urban mobility gap in cities and the 15 main metropolitan regions in Brazil[11] (i.e., three times the amount directed to the sector in the previous decade).

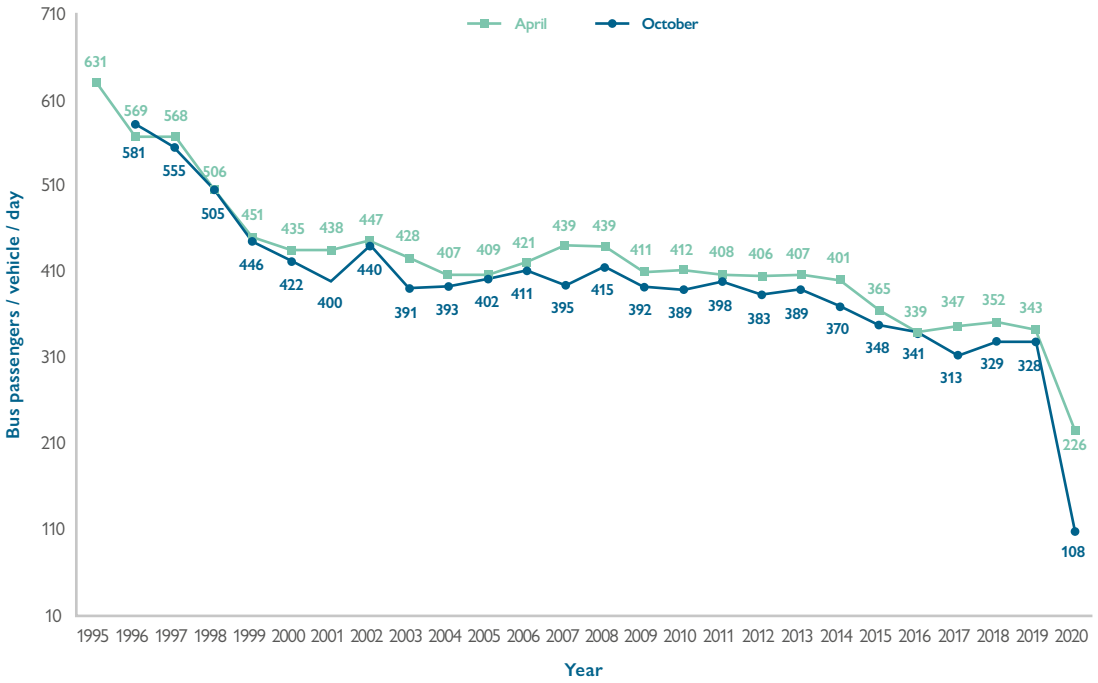



**Figure 2 | Number of bus passengers in Brazil between 1995 and 2020. Source: NTU (2022)[12].**

## 2.2 | SÃO PAULO

The City of São Paulo, located in the state of São Paulo, is Latin America's most populous city with around 12.3 million inhabitants, a territory of 1,521 square kilometers ($km^2$), and a population density of 8,150 inhabitants per $km^2$ [13]. São Paulo is the hub of the RMSP, formed by 39 municipalities with some 22 million inhabitants, constituting the largest urban agglomeration in Brazil[14]. In terms of income and employment, 45.7 percent of the total population was employed in the Municipality of São Paulo (Município de São Paulo, MSP) in 2020, earning an average of 4.1 minimum wages.

11 Amicci, A. G. N and Malburg, C. H. R (2018). Mobilidade Urbana. Visão 2035: Brasil, país desenvolvido. Agendas setoriais para o desenvolvimento. BNDES. Available at: <https://web.bndes.gov.br/bib/jspui/bitstream/1408/16262/1/PRCapLiv214206_mobilidade%20urbana_compl_P.pdf >

12 Anuário NTU 2020-2021. Available at: <https://www.ntu.org.br/novo/upload/Publicacao/Pub637677328510412847.pdf>

13 IBGE Cidades, São Paulo, Panorama. Brasília. Available at: <https://cidades.ibge.gov.br/brasil/sp/sao-paulo/panorama>

14 IBGE, Regiões Metropolitanas, Aglomerações Urbanas e Regiões Integradas de Desenvolvimento. Available at: <https://www.ibge.gov.br/geociencias/organizacao-do-territorio/divisao-regional/18354-regioes-metropolitanas-aglomeracoes-urbanas-e-regioes-integradas-de-desenvolvimento.html?=&t=acesso-ao-produto>

Transporting passengers and goods in a region of this size constitutes an enormous challenge. Containing 10 percent of the Brazilian population, the metropolitan area (RMSP) is the country's largest source of wealth, with a gross domestic product (GDP) in excess of R$2 trillion in 2018 (55 percent of the GDP of the state of São Paulo in only 3.2 percent of its territory). As home to some of the most important financial, industrial, and commercial companies in Brazil, the RMSP represents 17.7 percent of the national GDP and plays a leading role in the Latin American market, which depends on complex service networks requiring detailed planning in terms of the transport and circulation of people, goods, and information.

Rapid urbanization has resulted in substantial urban expansion toward the periphery of the RMSP, together with low rates of access to the high-capacity transit network, a significant increase in travel distances, and the daily occurrence of severe traffic jams. Of Brazil's 26 metropolitan regions, the RMSP has the greatest population density and the fourth-highest proportion of people (9 percent) living in favelas. The costs arising from traffic congestion in the RMSP are a serious drag on passenger and freight logistics, impacting negatively on the region's economic development, undermining competitiveness, and disproportionately affecting the poorest and most vulnerable inhabitants.

In terms of demand, according to the OD 2017 survey, around 42 million trips are made in the RMSP on a workday, representing an increase of 10.3 percent in total trips compared to 2007. In addition, of these trips 36.4 percent are made by public transport, 30.9 percent by individual motorized transport, 31.8 percent on foot, and 0.9 percent by bicycle[15]. It is worth noting that of the 42 million trips in the RMSP, about 57 percent are made exclusively in the City of São Paulo, indicating the high demand for transport in the city[16]. In addition, there is also a segment of users who face trips longer than two hours ("super commuters") and who undertake around 2 percent of all trips in the RMSP, with 93 percent of these trips being on public transport.

The RMSP public transport network comprises (1) the subway, operated by Metrô and two private concessionaires (ViaQuatro and ViaMobilidade); (2) urban trains, operated by the São Paulo Metropolitan Train Company (Companhia Paulista de Trens Metropolitanos, CPTM) and private operators (ViaMobilidade) of Lines 8 and 9; and (3) the bus transport systems, operated at the metropolitan level (Empresa Metropolitana de Transportes Urbanos, EMTU), at the municipal level (São Paulo Transportes S/A, SPTrans), and by other systems in the RMSP municipalities.

The metro (subway) system is located entirely within the boundaries of the MSP. The metro has about 104.4km of track, with 91 stations distributed over 6 lines—line 1 (blue); line 2 (green); line 3 (red); line 4 (yellow); line 5 (lilac); and line 15 (silver)—meeting a daily demand of around 5 million passengers[17]. Line 6 (orange) is under construction, and line 2 (green) is being expanded to the east side of the city. Line 17

15 Pesquisa Origem Destino 2017 - Relatório Síntese. Metrô, 2019

16 *Ibid.*

17 Metrô: Quem somos – saiba sobre transporte metropolitano. Available at: <http://www.metro.sp.gov.br/metro/institucional/quem-somos/index.aspx>

is also under construction and it will be operated by ViaMobilidade under Line 5 contract.

The CPTM operates 271 km of track with 95 stations in the RMSP, of which 135 km are within the MSP, distributed in 7 lines: line 7 (ruby); line 8 (diamond); line 9 (emerald); line 10 (turquoise); line 11 (coral); line 12 (sapphire); and line 13 (jade)[18]. In addition, CPTM fax serves 23 municipalities in the of São Paulo Metropolitan Region, transporting an average of 3 million passengers on workdays[19]. Figure 3 shows the distribution of train and subway lines in the MSP.

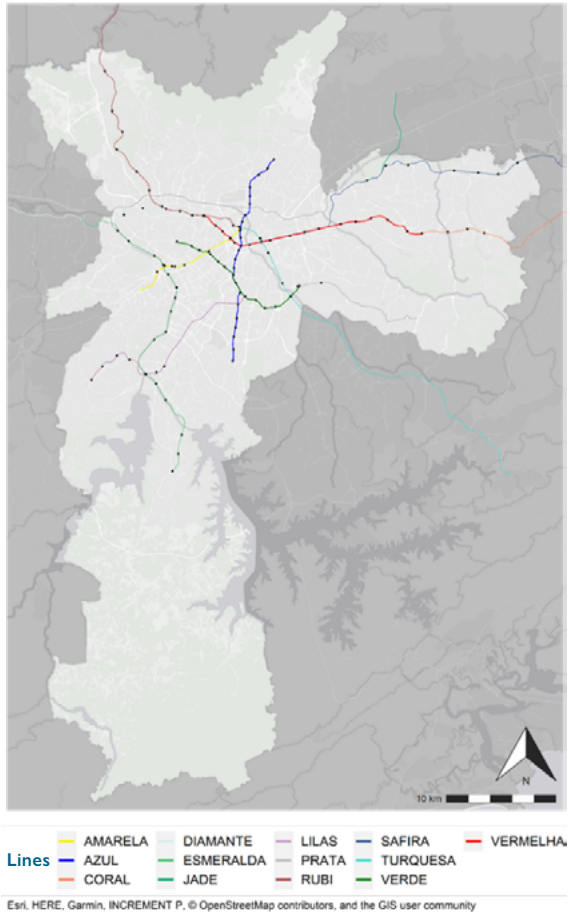



**Figure 3 | Map of rail lines in São Paulo. Source: PMSP (2022)**

To the metro railway system is added the metropolitan bus service—managed by EMTU—which is responsible for service in all the metropolitan regions and urban agglomerations in the state of

18 Visão Geral | CPTM - Companhia Paulista de Trens Metropolitanos. Available at: <https://www.cptm.sp.gov.br/a-companhia/Pages/a-companhia.aspx>

19 *Ibid.*

São Paulo. The network consists of 587 common and select lines in addition to the ABD corridor with its extension of 33 km and 9 terminals.

The public transport system in the City of São Paulo consists of buses controlled by the municipal government, complemented by the metropolitan public transport network, for which the state of São Paulo government is responsible. SPTrans, a company subordinated to the Executive Secretariat for Transport and Urban Mobility (Secretaria Executiva de Transportes e Mobilidade Urbana, SETRAM), which, in turn, is under the Municipal Secretariat of Mobility and Transit (Secretaria de Mobilidade e Trânsito, SMT),[20] is responsible for managing the bus system, planning, and programming lines and bus fleets, supervision, fare collection, hiring, and remuneration of operating companies. Most of the 8.1 million public transport trips in São Paulo are made by bus—5.2 million trips in all, representing 63.5 percent of public transport trips, with 21 percent of total trips in the MSP.

## SÃO PAULO HAS ONE OF THE LARGEST BUS TRANSPORT SYSTEMS IN THE WORLD

A fleet of around 14,000 municipal buses run on 1,300 lines covering 4,500 km of road.[21] Of these, 131.2 km (2.91 percent) benefit from corridor-type treatment, with different levels of segregation and priority for buses. More than 500 km of the roads provide operational priority in dedicated bus lanes, operating the Bus Rapid System standard, with exclusive operating direction (both ways) and timetables. Another 500 km of bus lanes are planned. Buses currently share the remaining roads with other vehicles. This leads to delays in service frequency and regularity, with public transport highly subject to variations in operating conditions, especially congestion, all of which affect the city's entire traffic management system. São Paulo also has 32 so-called integration terminals at the concession process,[22] and approximately 19,500 bus stops[23]. Figure 4 shows the distribution of corridors and exclusive bus lanes in the MSP.



20 The SMT, established and regulated by Decree No. 60.448 of August 9, 2021, replaces the former Municipal Mobility and Transport Secretariat.

21 Institutional presentation of SPTrans. Available at: <https://www.prefeitura.sp.gov.br/cidade/secretarias/mobilidade/institucional/sptrans/acesso_a_informacao/index.php>

22 Available at: <https://www.prefeitura.sp.gov.br/cidade/secretarias/governo/projetos/terminais_de_onibus_urbano/ppp_terminais/ >

23 Pontos de Parada | SPTrans. Available at: <https://www.sptrans.com.br/terminais-corredores-e-pontos-de-parada/pontos-de-parada/>

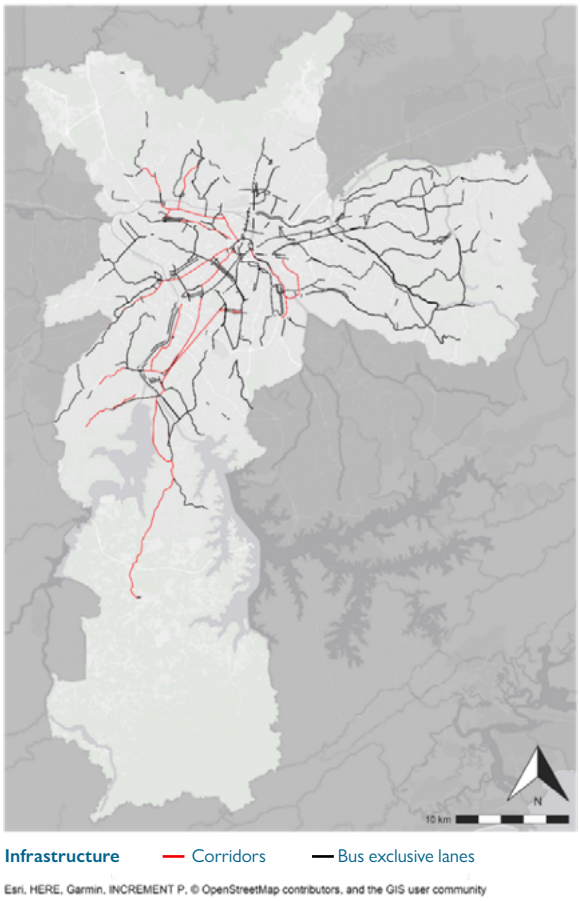



**Figure 4 | Dedicated and shared bus lanes. Source: São Paulo Transportes S/A (SPTrans) (2022).**

The road system in the City of São Paulo is approximately 20,000 km long[24] and has around 6,000 intersections with traffic lights[25]. In the 1990s, the city had 1,200 intersections with centralized traffic lights, but maintenance problems caused their use to be discontinued. The vehicle fleet is the largest in the country, with around 8.8 million vehicles, of which 67.5 percent are automobiles[26], and continues to grow. In the past 16 years, MSP's motorization rate (car and motorcycle) increased from 32 vehicles per 100 inhabitants to around 50 vehicles per 100 inhabitants (Figure 5), an increase of 56 percent.

24 Sistema de Consulta do Mapa Digital da Cidade de São Paulo. Available at: <http://geosampa.prefeitura.sp.gov.br/PaginasPublicas/_SBC.aspx#>

25 Sinal Verde. Available at: <http://cetsp1.cetsp.com.br/sinalverde/osSemaforosAgora.aspx#>

26 Frota de Veículos - 2021 — Frota por Município e Tipo. Brasília: Available at: <https://www.gov.br/infraestrutura/pt-br/assuntos/transito/conteudo-denatran/frota-de-veiculos-2021>

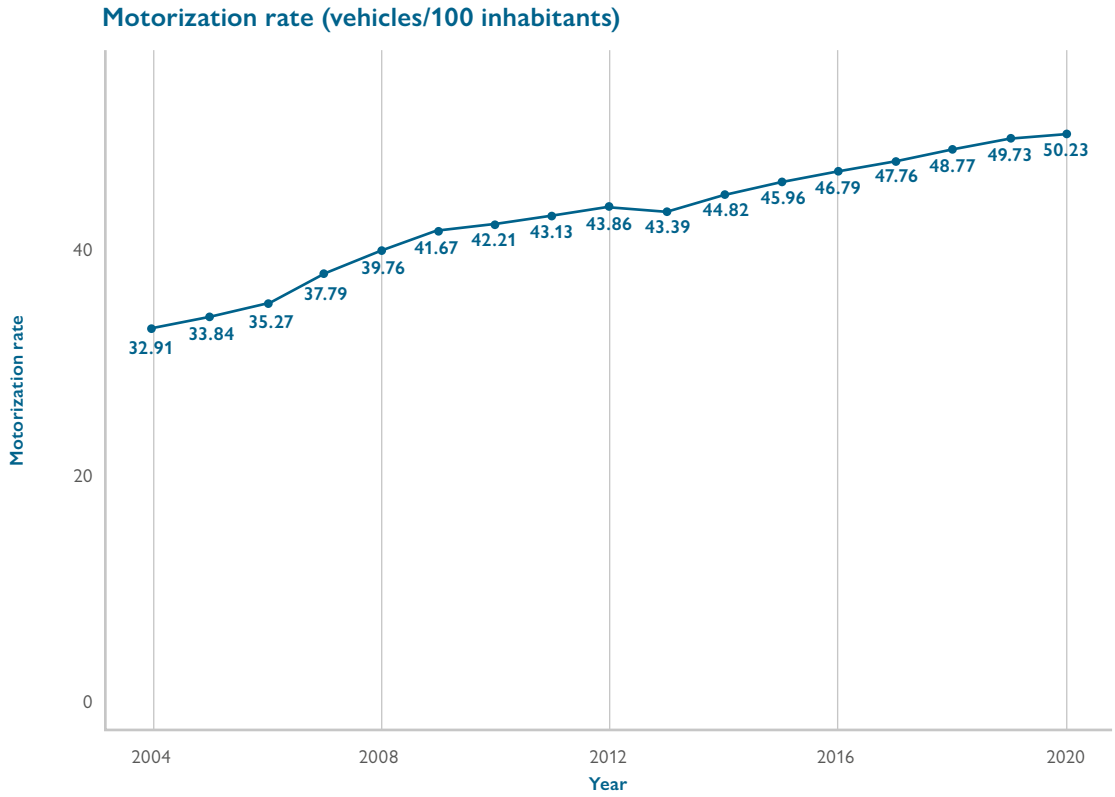



**Figure 5 | Motorization rate in São Paulo 2004-2020. Source Denatran (2021).**





Given the complexities and the size of the transport systems and related infrastructure in the city, various challenges are presented to managers and the population, who currently complain about the results of the use of individual motorized modes, such as congestion, greenhouse gas emissions, air and noise pollution, and traffic accidents—especially involving motorcycles[27]. Along with its history of prioritizing infrastructure for individual motorized modes, the city also suffered the impacts of the COVID-19 pandemic, which has largely caused the population to shy away from the public transport system. Even after the return most normal activities, public transport demand has not yet returned to pre–COVID-19 levels.

Plans to improve urban mobility include those laid out in the 2015 Mobility Plan (PlanMob 2015)[28], which sets different goals and strategies for expanding both the public transport and bicycle systems, and deploying more bus- corridors. However, the key objectives of the plan have not yet been achieved, and priorities have to be negotiated.

The city's traffic lights network still depend on old technologies that generate very substantial main-

27 Mobilidados: Taxas de fatalidades no trânsito na RMSP. Available at: <https://mobilidados.org.br/rms/rmsp>

28 PlanMob 2015. Available at: <https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/chamadas/planmobsp_v072__1455546429.pdf>

tenance costs, and are likely to fail (a common complaint on social media).

SPTrans is working to assist groups such as women, people with disabilities, black and indigenous people, and the elderly. Activities to combat racism and sexual harassment in buses and terminals, as well as the Atende+ Program, are positive steps. But the complex reality of both the City of São Paulo and the larger metropolitan region urgently call for more social inclusion policies that enable vulnerable population groups to access buses and other public and active transport modes safely and economically. A key initiative is the Climate Action Plan (PlanClima SP 2020)[29], which promotes actions to reduce greenhouse gases in the transport sector by reducing travel distances, and encouraging people to use public transport and active modes of travel.

## ACTIVE MOBILITY IN SÃO PAULO

The cycle network expanded rapidly between 2014 and 2016, with the addition of 400 km of cycle paths and lanes. At present the city has 667.1 km of bicycle paths and permanent cycle lanes and 32.1 km of cycle routes[30]. It plans to expand the cycle-friendly network to 1,800 km by 2028. Several aspects of network design and connectivity still need to be improved, as well as factors related to social inclusion. Until these issues have been addressed, it is difficult to forecast the impact of expanded bicycle use.

The Traffic Engineering Company (Companhia de Engenharia de Tráfego, CET) is charged with improving pedestrian, especially child, safety. MSP has established an emergency sidewalk program, and made headway to create spaces with pedestrian priority in certain areas of the city. At the moment, a mere 12 percent of urban space is for exclusive pedestrian use, and only 9.2 percent of all sidewalks are accessible to people with reduced mobility. Given these problems there is obviously a need to take this agenda forward.

## TARIFFS ARE STREAMLINED, BUT NOT MOBILITY GOVERNANCE

In 2004, the City of São Paulo implemented a single ticket system (Bilhete Único, BU) for cheaper fare payment and easier access to public transport systems. The BU user is entitled to up to four departures in a period of three hours at no additional cost, in addition to a discount on integrated

29 PlanClimaSP. Plano de ação climática do Município de São Paulo 2020-2050. Available at: <https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/meio_ambiente/arquivos/PlanClimaSP_BaixaResolucao.pdf>

30 Plano Cicloviário do Município de São Paulo. Available at: <http://www.cetsp.com.br/media/1100812/Plano-Ciclovia%CC%81rio_2020.pdf>

trips between the bus and metro railway systems[31].

From an administrative point of view, a large number of stakeholders are involved in the MSP and RMSP transport systems. Figure 6 summarizes the functions and competences of these practitioners and the relationship between the systems and other entities.

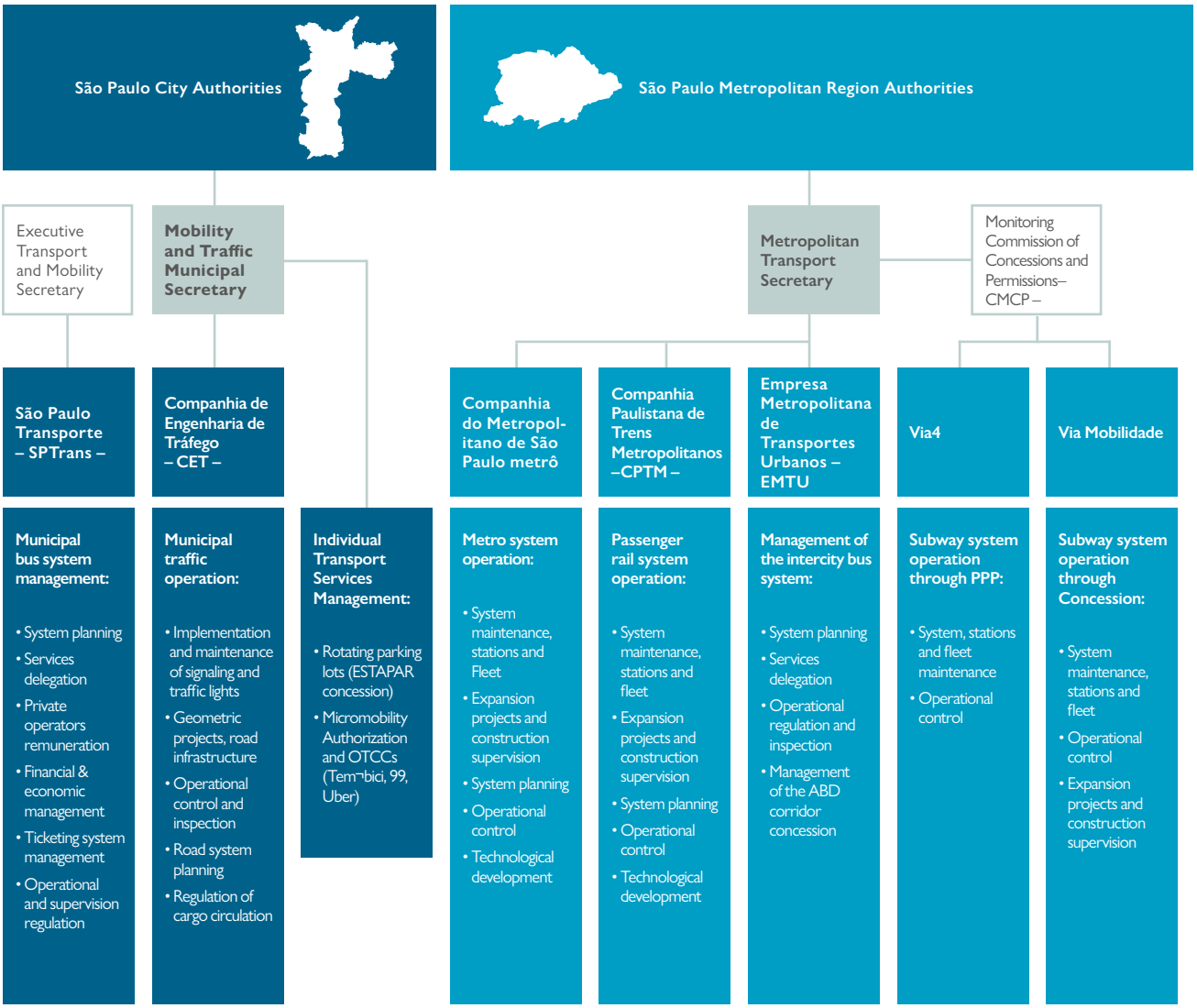
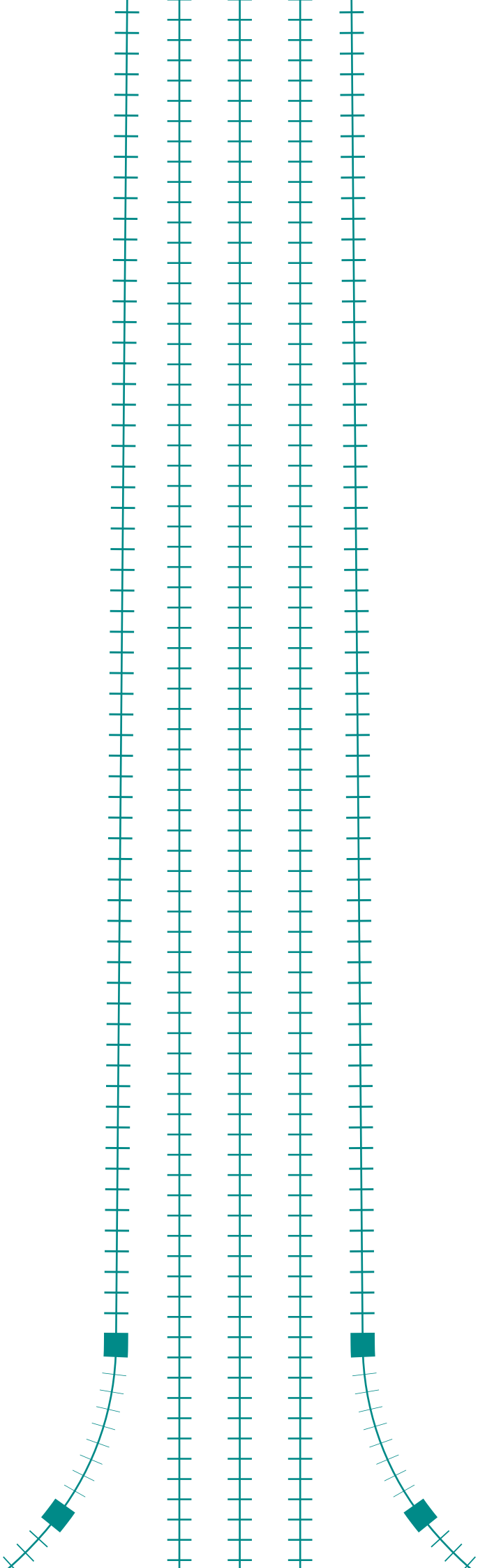



**Figure 6 | Main stakeholders and responsibilities in the MSP transport system. Source: World Bank (2022).**

The City of São Paulo does not yet have an integrated interface for its different transport systems. Instead, each mobility mode has its own platform, leaving users to navigate their variety. Also, the

31 Tarifas | SPTrans. Available at: <https://www.sptrans.com.br/tarifas/>

complexity of operations makes the planning and management of São Paulo's transport systems difficult. Central, integrated management of the various systems would enable people to move from one transport mode to another seamlessly, safely, and conveniently, in the spirit of *Mobility as a Service*. In such a complex context is difficult to discuss the planning and management of the city's transport systems in a way that better mobility conditions for the population can be guaranteed.



# CHAPTER 3

# 3 | A SMART CITY IS A "CITY FOR EVERYONE"

A smart city uses the latest technological infrastructure to more efficiently manage urban services and enhance connectivity. Although technology is an essential component of such a model city, in reality it is simply one more tool to achieve the goals of equality, economic growth, poverty reduction, and a better quality of life. In short, technology is just one of the elements that contribute to the consolidation of an efficient and sustainable city.

This study recommends an urban management approach focused on the people who actually live in a city. It also broadens the concept of a smart city to mean a "city for everyone," a welcoming space that provides access to economic, political, and social opportunities for all segments of the population. It follows that public policies and investments first need to be planned with a view to making a city both humane and inclusive.

A smart city is efficient, safe, fair, equitable, environmentally sustainable, and clean. Merging all these aspects into public policies is only possible if they are conceived in an integrated manner. Information and communication technology, and systems integration, are both crucial.

These considerations underlie the various activities of the Smart Mobility Program. In the course of scoping the activities, an integrated conceptual model of a smart city gradually emerged, as illustrated in Figure 7.

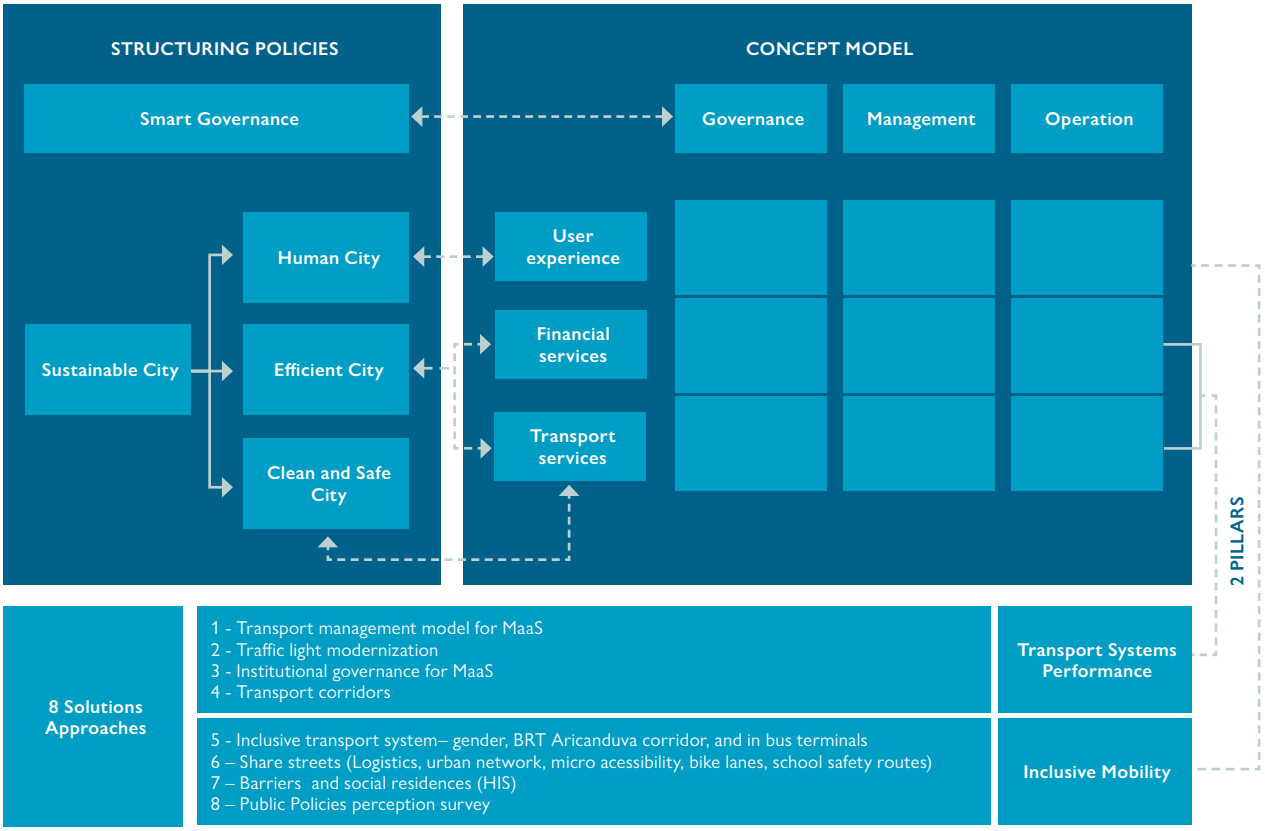



**Figure 7 | Integrated conceptual model of a smart city. Source: World Bank (2022).**

The left side of the diagram lists structural policies to support the program framework consolidation.

The right side of the diagram links three approaches (governance, management, and operation), with three service elements (user experience, finance, and transport provision). Each bloc of this conceptual matrix contains the solution to one or more of the challenges addressed by a smart city. The bottom part of the diagram details those solutions addressed in Program-related studies, the links between them, and their position in the conceptual matrix.

The conceptual matrix is important because it sets a framework for the actions of the São Paulo City Hall, the São Paulo state, and other municipalities in the Metropolitan Region of São Paulo (including its corporate organization) in terms of apportioning functions and responsibilities. Smart management tools may be used to deliver information on the status of each mobility sector, informing decision-making processes.

The solutions proposed, and their integration, would contribute to the operationalization of the conceptual model. As for next steps, it is suggested that the challenges that have not yet been addressed should be the subject of new studies, while the studies already undertaken be reviewed

and validated. These studies may be regarded as benchmarks for São Paulo. Other cities in the region and around the world may also use the study proposals as guidelines for designing their own mobility systems, and as a basis for scoping terms of reference.

# CHAPTER 4

# 4 | MOBILITY MANAGEMENT CHALLENGES, AND A THEORY OF CHANGE

## 4.1 | CHALLENGES

Chapter 2 highlights the complexity of the challenges to mobility in the Municipality of São Paulo (MSP). It also draws attention to the city's ongoing progress toward greater inclusion, sustainability, and efficiency.

The World Bank team and the São Paulo City Hall (PMSP) conducted a joint in-depth analysis of factors behind key challenges, and key actions to address them. In the course of this analysis, the main objectives of the Smart Mobility Program were established, as follows:

- Achieve full economic development, shared with the most vulnerable populations, integrating transport planning with land use/occupation planning.
- Promote a more sustainable modal split in economic, social, and environmental terms, promoting the use of both public and active modes of transport.
- Ensure full integration (physical, operational, tariffs, management, and technology) of municipal and metropolitan transport networks.

- Deploy and maintain a smart and resilient traffic light network.
- Expand the bus lane system, creating a time horizon for its prioritization and implementation.
- Promote a policy for the sustainable sharing of urban space and roads, prioritizing pedestrians, bicycles, and public bus transport.
- Ensure solutions for urban mobility that are inclusive in terms of age, disability, sexual orientation, gender, and race, minimizing barriers to transport accessibility.
- Promote and monitor actions to reduce negative views about public transport through policies to improve road safety and atmospheric emissions associated with the movement of goods and people.
- Promote and monitor the economic/financial health of urban mobility systems in order to help construct, manage, and adequately maintain transport infrastructure.
- Consolidate modern, transparent, and effective means of communication with users.

The results of this analysis, summarized in Figure 8, helped define the activities conceived in the Smart Mobility Program (and structured using the program's Theory of Change, as explained in the following section).

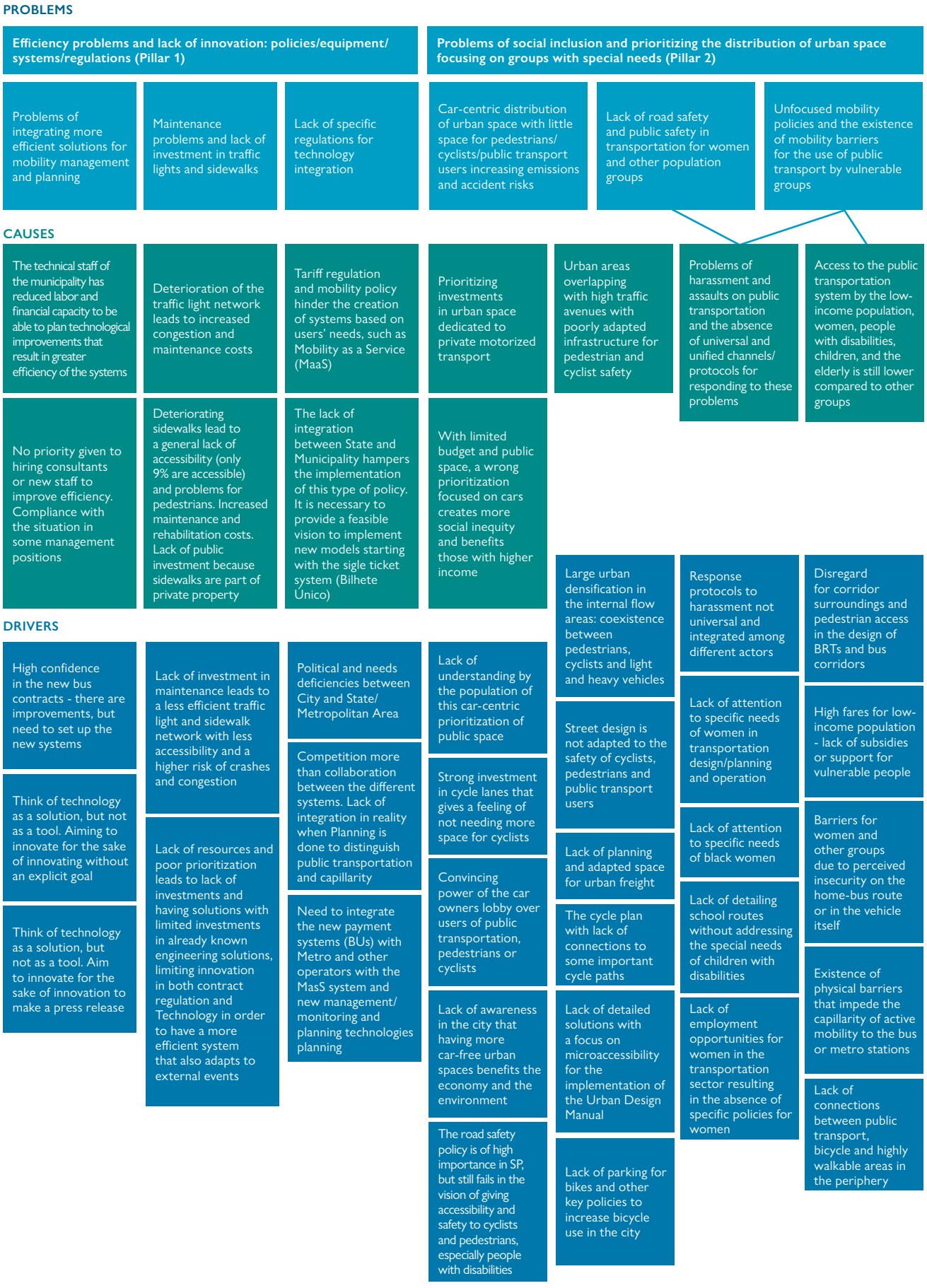



**Figure 8 | Analysis of key problems and their causes. Source: World Bank (2022).**

## 4.2 | PROPOSED SOLUTIONS

Developing a theory of change begins with identifying the motivations behind an intervention, and assessing its intended outcomes. The Smart Mobility Program's theory of change is based on the following assumptions: (1) the ultimate objective of public policy is to improve the welfare of beneficiaries; and (2) this welfare achieved through the best possible combination of goods (market and nonmarket) and services that deliver in spite of socioeconomic constraints. Changes in these constraints are the main channels through which policy interventions affect well-being at the individual or family level.

This approach was successfully applied to structuring and implementing the Smart Mobility Program, enabling identification of the two pillars of the Program, the activities to be carried out, and the expected results and impacts. These impacts were identified, both individually and collectively, as improving the efficiency and **effectiveness of mobility planning, management, and accessibility aimed at better meeting the needs of those who live in the city, especially the most vulnerable.**

- Pillar 1, related to transport systems efficiency, centers on solutions to the problems of a low level of technological integration of systems (both within the same entity and across entities involved in the mobility environment) and the very limited use of available computer (big data and artificial intelligence) and telecommunication technologies (wireless and 5G sensors), in planning, operations, and surveillance. Related studies proposed that the PMSP progress toward more efficient management of the transport infrastructure by upgrading technology and making necessary changes to legal and business models. These would be major steps toward implementing a MaaS platform for the City of São Paulo. This in turn would improve the supply of mobility services and encourage a shift to public transport and active modes of travel.

- Pillar 2 focuses on inclusion and equity in the use of mobility systems. Related activities seek to improve the regulatory and policy framework governing the MSP transport sector (public and individual, motorized and active modes, movement of people and goods, etc.), focusing on vulnerable segments of population such as women, low-income groups, and people with disabilities. Critically important issues for the city were addressed, ranging from safety to the equity of the transport network (e.g., more sustainable allocation, and fairness of the use of road space and associated resources) and measures for overcoming physical, social, and cultural barriers that prevent certain groups from taking full advantage of mobility services. In-depth analyses were followed by proposals, developed jointly with several stakeholders, to structure policies to improve mobility, and eventually create a fairer and more sustainable city.

Figure 9 and Figure 10 (Pillars 1 and 2) summarize the various elements of the theory of change that informed the conception and development of Program activities.

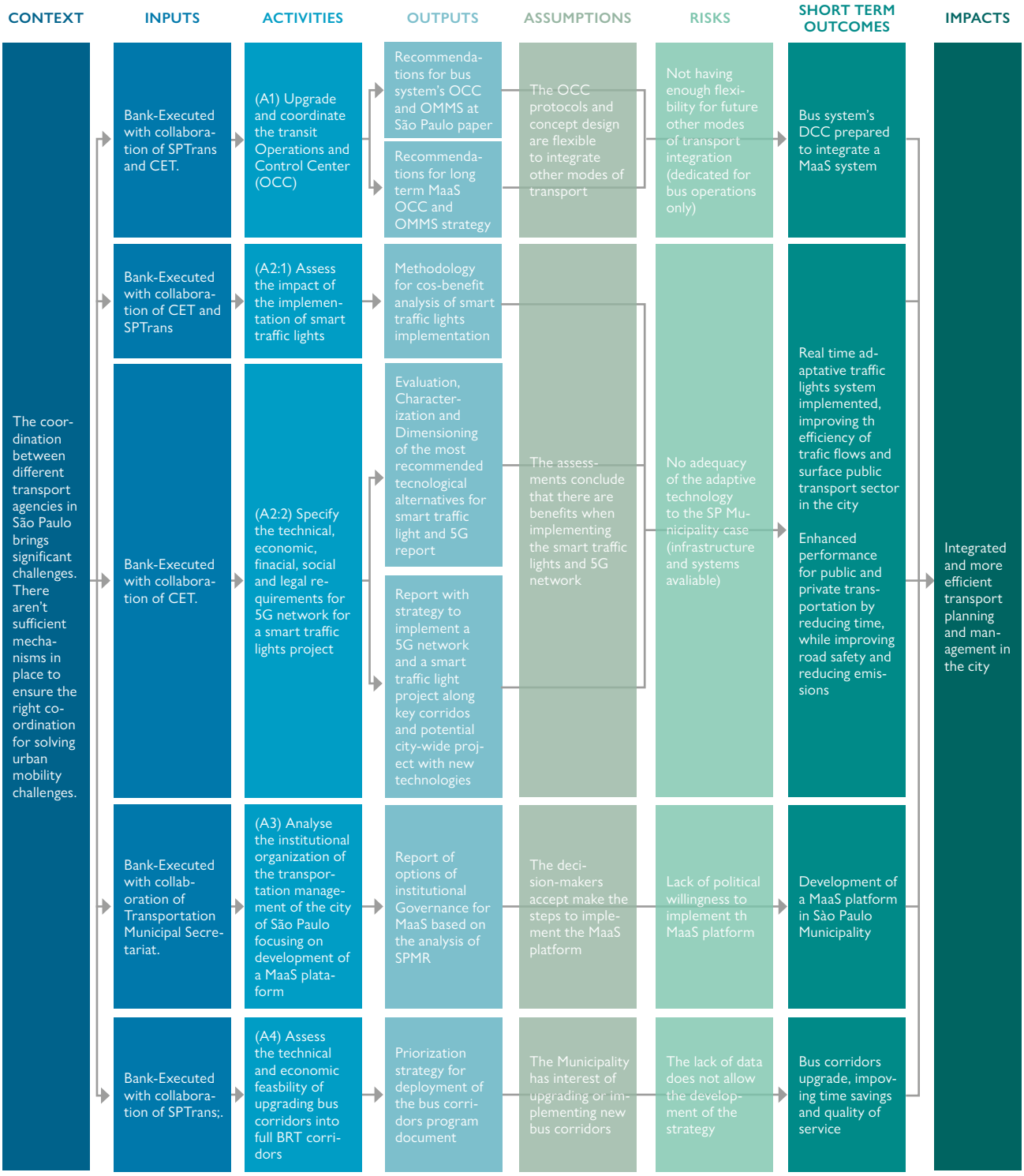



**Figure 9 | Theory of Change, Pillar 1. Source: World Bank (2022).**

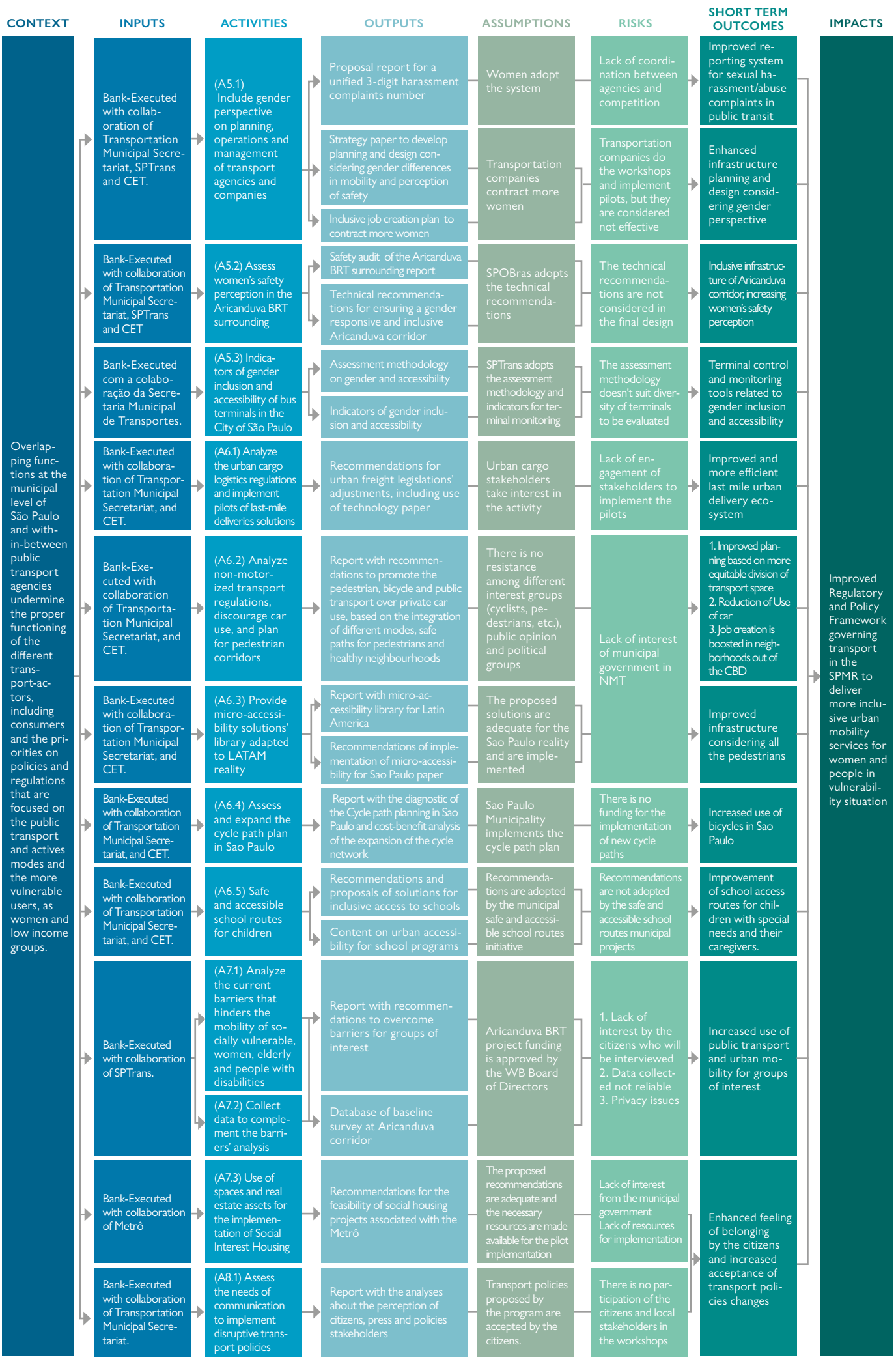
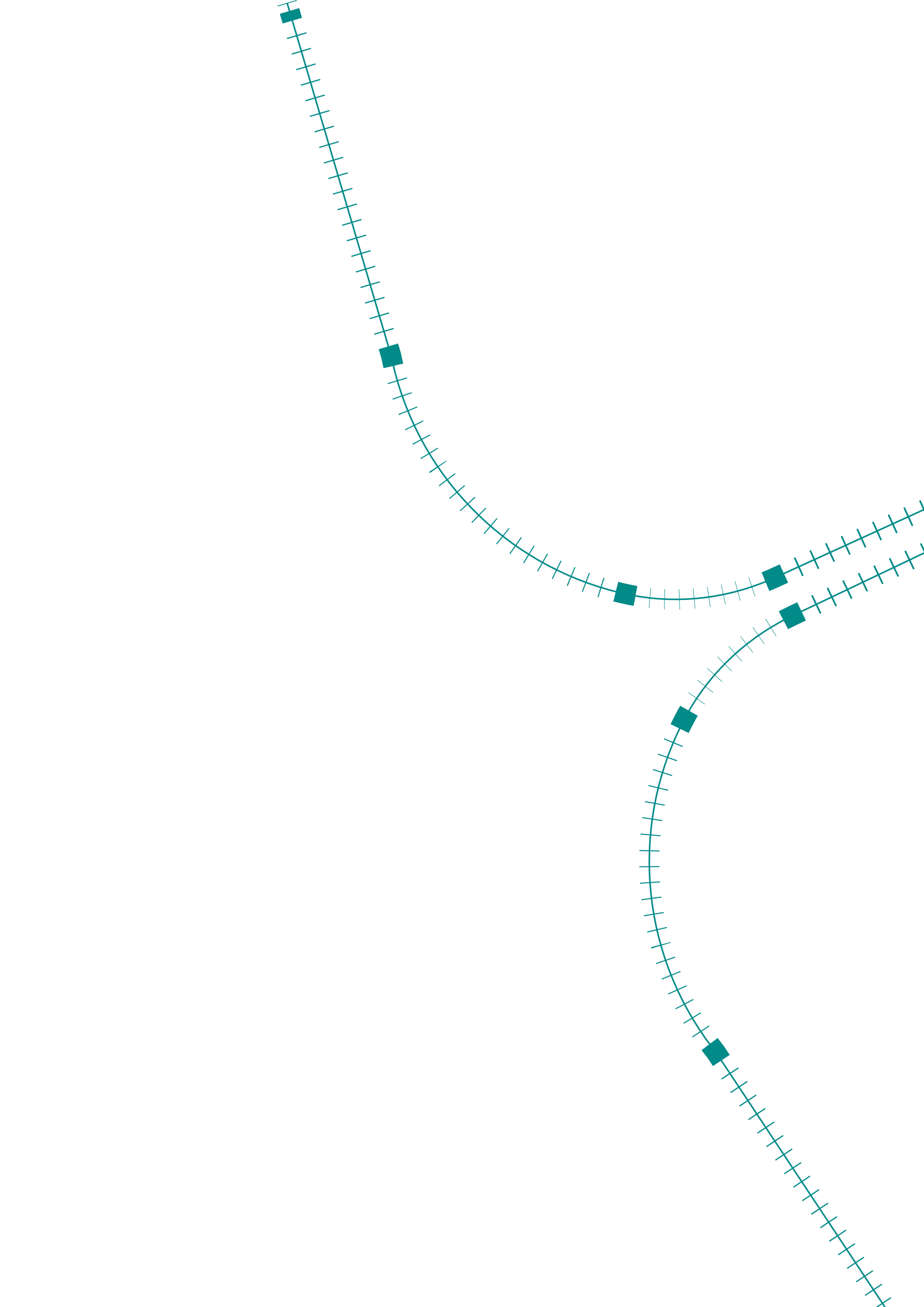
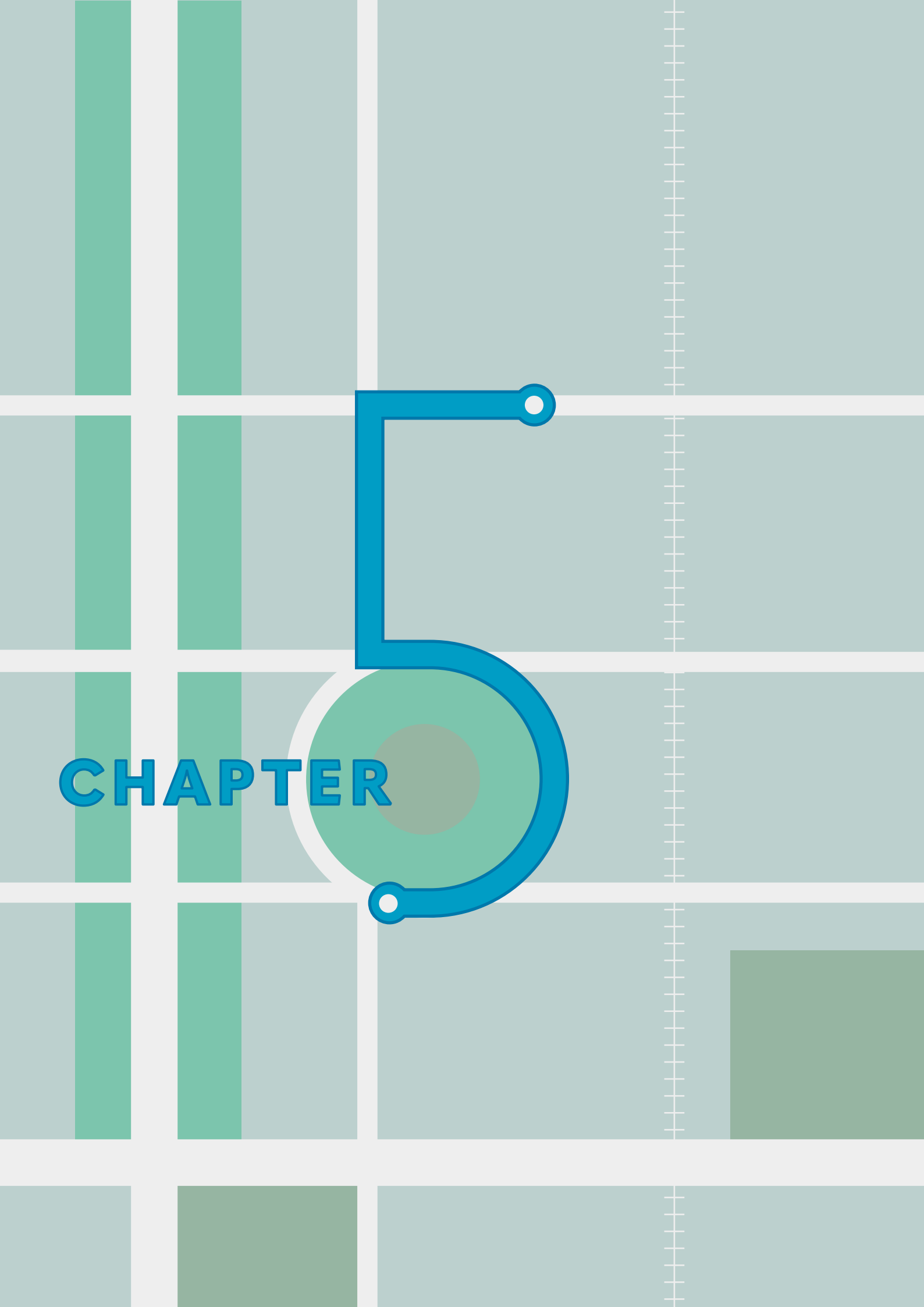



**Figure 10 | Theory of Change, Pillar 2. Source: World Bank (2022).**




CHAPTER
5

# 5 | DESCRIPTION OF ACTIVITIES: OBJECTIVES, RESULTS, AND RECOMMENDATIONS

This chapter outlines each activity recommended under the Smart Mobility Program, including context, objectives, the various work stages involved, outcomes, and recommendations for the City of São Paulo. The activities are categorized according to the Program's two pillars::

- **Pillar 1: Improving efficiency in the management, planning, and operation of public transport, as well as in the regulations related to urban mobility.**
- **Pillar 2: Furthering decarbonization, sustainable mobility, and social inclusion policies.**

The activities related to the Aricanduva Bus Rapid Transit project are also considered, along with recommendations to improve the design and implementation of infrastructure projected to serve more than a million people on the east side of São Paulo.

# 5.1 | PILLAR 1 ACTIVITIES

## 5.1.1. ACTIVITY 1: SUPPORT FOR THE NEW SPTRANS OPERATIONS AND CONTROL CENTER (COP): INTEGRATING ARTIFICIAL INTELLIGENCE, BIG DATA, AND MOBILITY AS A SERVICE (MAAS) IN THE PLANNING AND OPERATION OF PUBLIC TRANSPORT BY BUS.

### CONTEXT

Around 8.1 million trips are made daily in the City of São Paulo using public transport modes, amounting to a third of all trips. Of these, 63.5 percent involve use of the bus system as the main mode, representing 21 percent of total trips. Improving the efficiency of such an extensive network requires considerable effort to manage, monitor, and plan the operation. This must be guided by a data-based analytical approach which can be improved by the use of the latest technologies of artificial intelligence and big data and by integrating present and future transport systems to ensure the conditions needed for the future deployment of the MaaS concept.

### OBJECTIVES

One of the activities provided for in the financing of the Aricanduva BRT is the improvement of the Sâo Paulo Transportes S/A (SPTrans) operational control center (CCO) with the installation of advanced technological resources for monitoring and planning processes. This enhancement should benefit not only the bus corridor users, but also the millions of daily bus passengers in the Municipality of São Paulo (Município de São Paulo, MSP).

The present study aimed to identify the latest technologies for CCOs that will allow real-time measurement of critical service performance indicators to be introduced in new contracts. Solutions were identified to improve the quality and efficiency of the MSP bus system, based on better integration with other modes of transport and an information system available to the population and public authorities.

The specific objectives of the project were established as follows:

i. Provide technical support to SPTrans in the design of a georeferenced information system for mobility and accessibility with analytical functions based on artificial intelligence and big data technologies, called SIGMA (Sistema de Informações Georreferenciadas de Mobilidade e Acessibilidade).

ii. Support SPTrans in detailing the functionalities of an information system for monitoring and operational control of the fleet, called SMGO (Sistemas de Monitoramento e Gestão Operacional), with real-time control according to the guidelines contained in annex VII of the concession agreement in progress.

iii. Develop recommendations for the integration of SIGMA and SMGO with other systems (present and future) in a single technological environment of SPTrans and of the CCO itself with the other existing CCOs in the metropolitan region, as important steps toward the implementation of a MaaS platform.

## WORK STAGES

The study lasted 15 months and was developed using a four-step design-thinking methodology (understanding, definition, ideation, and roadmaps) resulting in 11 reports grouped into 5 products, as shown in Figure 11.

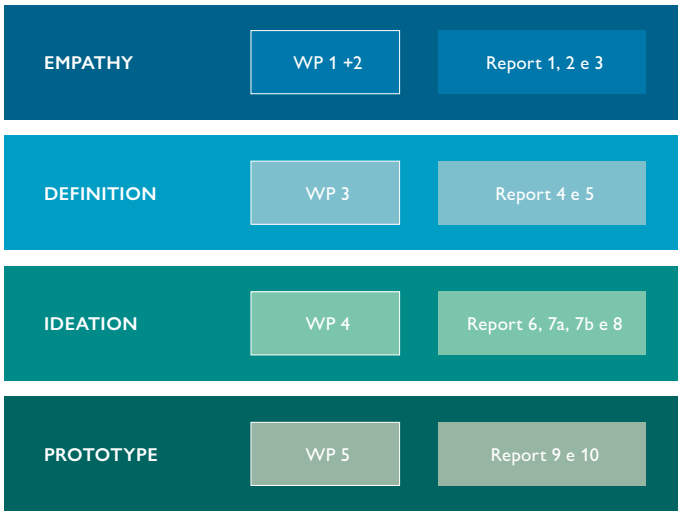



**Figure 11 | Stages of the design-thinking methodology. Source: World Bank (2022).**

## RESULTS

As a main result of the process, centralized systems architecture was identified as the most suitable for SPTrans' needs in the current scenario and for a future MaaS scenario (figure 5.2).

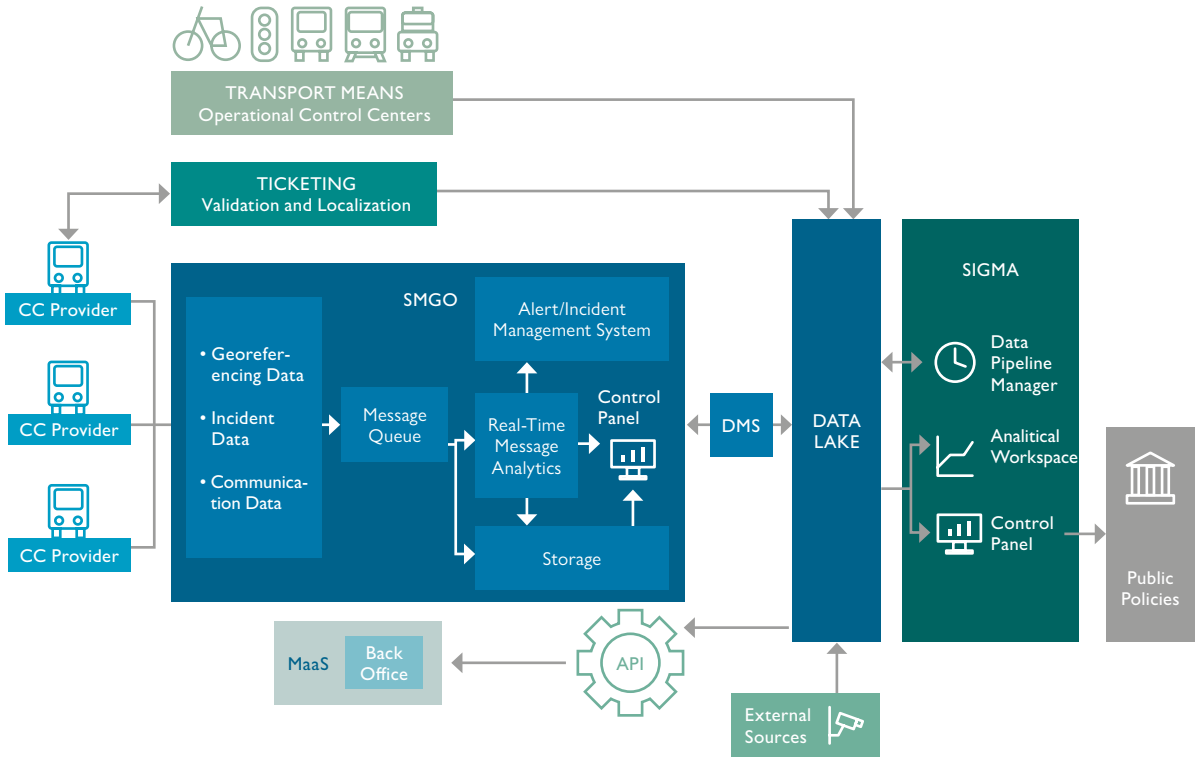



**Figure 12 | Proposed Architecture of the System. Source: World Bank (2022)**

The proposed architecture of the system comprises the following components:

i. An integrative environment for the SIGMA management system and the SMGO, MaaS, ticketing and control centers (CC transport means) of operators of the remaining submodes, in addition to omnibuses, including the subway, trains, individual transport, the São Paulo Metropolitan Urban Transport Company, private operators of motorized transport, and the SPTrans control centers (CC providers).

   a. Na. In this integrative environment, a Data Lake[32] will play a fundamental role as a structured repository of data, mirroring the specific original bases of each subsystem and recording tabulated information to be used by all.

   b. Thanks to the design of this environment and the use of big data and artificial intelligence tools, it will be possible to achieve a new level of analysis and planning of the services already provided, as well as of new services.

32 A Data Lake is a repository used to store all structured and unstructured data. By storing them in an unstructured way, different types of analysis can be performed, including Big Data processing, real-time analysis, and machine learning.

ii. SIGMA—functionalities detailed during the study.

iii. SMGO—functionalities also detailed during the study.

iv. The ticketing system under review by the São Paulo City Hall (Prefeitura Municipal de São Paulo, PMSP).

v. The MaaS platform is being analyzed and contracted by the PMSP.

These components will be key to the deployment of a big data system that can be monitored in real time and from which data can be extracted for improving the management and planning of the system, including integrating bus lines in corridors that are currently being established or are at the planning stage, such as the Aricanduva BRT Corridor. These systems will need to be controlled by the new CCO located in Santa Rita, which is being designed and built and is already prepared for the future implementation of all the systems recommended under this action. The next steps to be taken by the MSP include organizing the bidding process and funding for the detailed design and deployment of the SIGMA and SGMO systems in the coming years.





### RECOMMENDATIONS

In addition to recommending the conceptual model and functionalities of SIGMA and SGMO, it is suggested that complementary studies should be scoped focusing on the development of the abovementioned components and systems. These studies should be considered as part of the new investment operations in the new corridors, as a possible way to ensuring the availability of resources to develop the proposed systems. Such complementary proposals could include developing SIGMA further by including the module for monitoring additional bus lanes based on the conclusions of this study, as well as examining the possibility of integrating ticketing issues and those related to corridor infrastructure maintenance.

## 5.1.2. ACTIVITY 2.1: MICROSIMULATION OF MOBILITY ALONG THE ARICANDUVA BRT CORRIDOR

### CONTEXT

Among the São Paulo Urban Mobility Plan (Plano de Mobilidade - PlanMob)proposals is the corridor plan, which highlights the implementation of more than 565 km of exclusive bus corridors, in addition to

the 131 km of corridors already existing in the city. One of the corridors prioritized by the plan is the 14-km long Aricanduva BRT.

The Aricanduva BRT Corridor Project is considered to be a key element for structuring transport services and improving the urban environment in the area, since approximately 290,000 passengers use bus services in the corridor daily. Around 1.2 million people (potential beneficiaries) live in the corridor's catchment area, including 29,000 in precarious housing conditions.

During the preparation of the basic engineering project, discussions were held about the basic geometry of BRT deployment and the infrastructure needed for active mobility (e.g., space for bike paths and sidewalks), to be compatible with the presence of heavy vehicles, given that the avenue is an important freight thoroughfare for the city. The issues raised by the agencies involved in implementing the BRT (distribution of space for the different modes and the circulation of motorized traffic) were in due course included in the plans for the microsimulation activity with a view to producing data to support the internal decision-making process with respect to selecting the best design options available.

## OBJECTIVES

The main objective of the microsimulation study of the Aricanduva BRT Corridor was to develop a methodology to evaluate, through traffic simulation, the benefits of implementing different types of geometry and real-time traffic control strategies to improve the performance of the transport system in terms of flows of automobiles and, especially, of public transport. The outcome of the activities constituted a methodological evolution in the use of simulation tools for the ex ante evaluation of transport projects by the PMSP's decision-making process. Three additional objectives related to the corridor were also considered:

i. Evaluate the performance of concrete engineering structures to improve traffic performance.

ii. Evaluate technological alternatives for traffic control.

iii. Inform the executive design of the corridor with functional geometry references.

## WORK STAGES

This activity was divided into two stages. First, traffic simulations were performed across a large area to evaluate the Metropolitan Region of São Paulo (Região Metropolitana de São Paulo, RMSP) road network. Based on the results of these simulations, submatrices of the study area (the Ari-

canduva BRT Corridor) were calculated. Second, a microsimulation of the corridor was developed based on the definition of performance indicators, which served to rate the results of the simulations, and of the scenarios selected for comparison purposes. The performance indicators adopted in this study were: average speed, delay, queue length, and service level. All the indicators were calculated for the general network, aggregated and detailed by link, node (intersection), corridor sections (Figure 13), direction, and type of vehicle (car and bus).



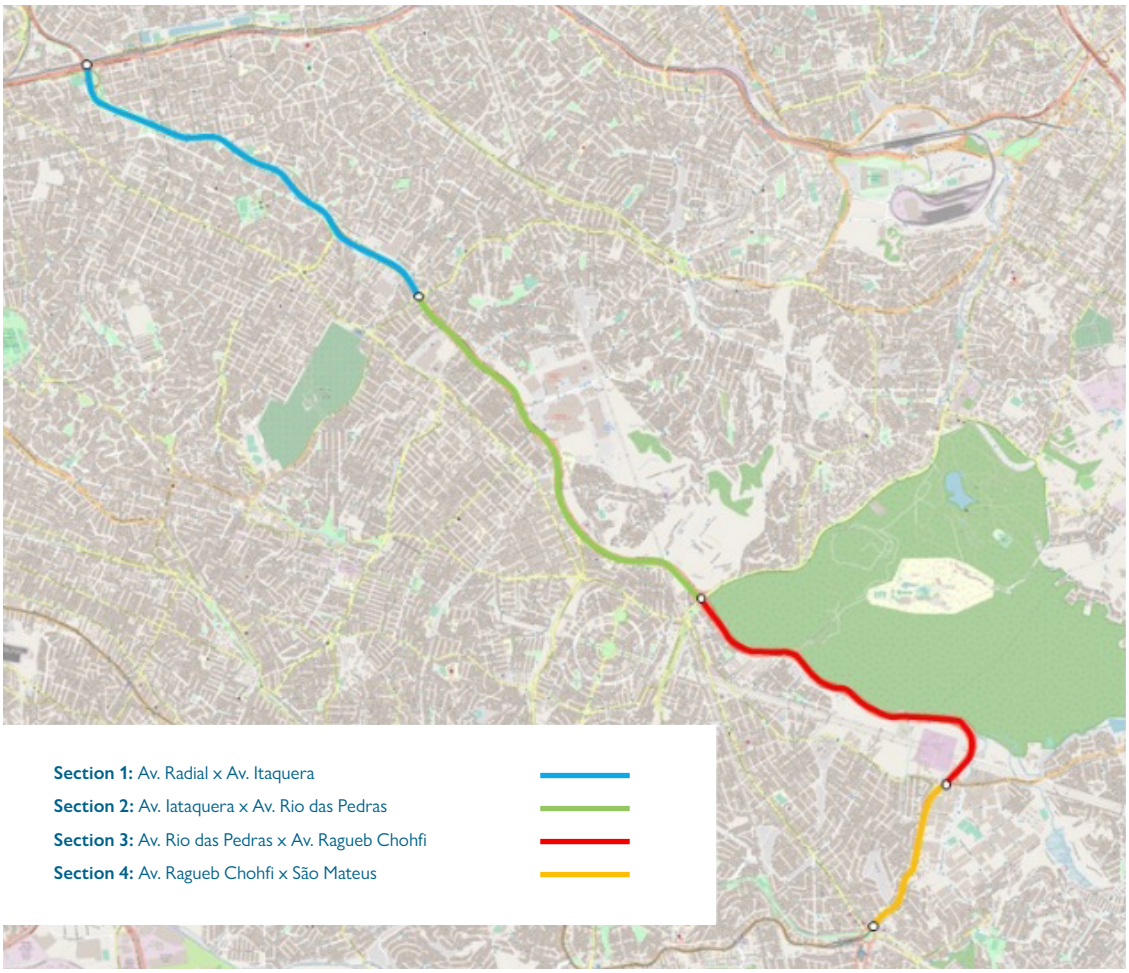



**Figure 13 | Sections of the Aricanduva corridor. Source: World Bank (2021).**

To evaluate the performance of the different proposed geometry configurations, the following simulation scenarios were defined:

- Base
- Corridor geometry (A0)

- Geometry of the Corridor plus the Ragueb Viaduct (A1)
- Geometry of the Corridor plus the Itaquera Viaduct (A2)

The simulation period was one hour, depending on the availability of data collected by the CET, between 7:30 am and 8:30 am (peak morning time for the study area). An initial 30 minutes were added to this period for the traffic load preliminary warm-up phase in the network. The flowchart in Figure 14 shows the different phases of the activity.

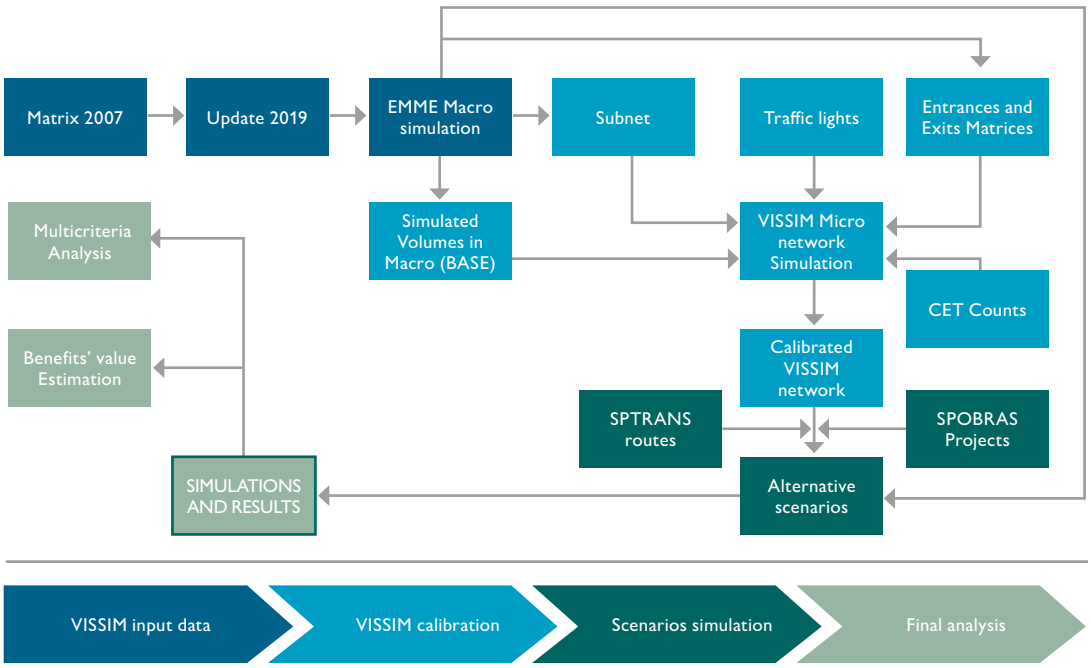



**Figure 14 | Methodology for developing the model. Source: World Bank (2022).**

It is important to point out that this activity was developed jointly between World Bank consultants and technicians from the CET planning divisions. Inputs from other agencies were also essential for fine-tuning proposals for the simulated scenarios..

## RESULTS

This study aimed to develop a method for evaluating the deployment of bus corridors through *ex ante* evaluation by means of traffic simulation. Performance indicators were calculated for each of the defined scenarios, following the definition of the study area, calculation of corridor demand, and cali-

bration of the model. The simulation of the proposals highlighted potential inconsistencies and design flaws that were the subject of discussion among the stakeholders involved.

The results of the indicators were used internally by CET, São Paulo Works (SPObras), and SPTrans as references for discussing design alternatives for the BRT Aricanduva Corridor, weighing and comparing the different traffic indicators and their general contribution to each of the proposed alternatives.





## RECOMMENDATIONS

The study's methodological approach to training the CET teams was invaluable in assisting them to identify alternatives and proposals for organizing and using input data and indicators for future microsimulation models for the deployment of new bus corridors.

The work showed the importance of the calculated indicators (average speed, delay, and queue length) for validating the proposed projects, enabling the identification of problems that the projects may present and, after adaptation, serve as a benchmark for further decision-making. Consideration of the different perspectives and dimensions offered by indicator analysis greatly enriches the use of this type of tool. The study also indicated important metrics for model calibration, highlighting discrepancies that may exist between the various data sources used, as was the case of this study, which used large-scale and granular data to compare the simulated results.

Finally, the activity contributed to the technical development of the CET team and other PMSP bodies and succeeded in creating a data analysis model to be used in the evaluation of future city bus corridor projects. Also noteworthy was the progress made by PMSP in bringing together a variety of agencies to define the project at the simulation development stage.

### 5.1.3. ACTIVITY 2.2: EVALUATION, CHARACTERIZATION, AND SCOPING OF THE MOST PROMISING TECHNOLOGICAL ALTERNATIVES FOR SMART TRAFFIC LIGHTS AND 5G TELECOMMUNICATIONS TECHNOLOGY

## CONTEXT

To tackle the growing congestion problems in the city, PMSP has gradually adopted initiatives in line with the guidelines for prioritizing active and public transport, such as sidewalk renovation programs, bicycle sharing, and expansion of the cycling network. High demand for bus services, large numbers of cars in circulation, and the number of trips by active modes, combined with a complex transport system, call for technologies to support flexible and on-demand solutions for traffic control that also

meet the needs of urban mobility, notably active mobility and public transport.

The city has 5,886 intersections with traffic lights, of which 4,297 are independent (73 percent) and 1,589 are dependent[33] (27 percent). This infrastructure is operated by CET, which contracts private companies for maintenance and modernization services based on public bidding. In the 1990s, São Paulo's traffic light system included one of the largest SCOOT[34] networks in the world, which gradually fell into disrepair over the years. At present there is no intersection where flow control is optimized in real time, and the traffic light system as a whole suffers from maintenance problems and is unable to adapt to increasingly frequent extreme weather events. A public-private partnership (PPP) was recently initiated for the management of the traffic light systems that it is being renovated.

## OBJETIVOS

O presente estudo teve como objetivo apoiar a equipe da CET na concepção de uma estratégia para a otimização da gestão inteligente de tráfego a partir da adoção de tecnologias pioneiras de telecomunicações 5G, que abre a perspectiva de novos campos de aplicação e soluções para problemas persistentes. O estudo também analisou as possibilidades de financiamento para viabilizar os investimentos necessários. O estudo incluiu coleta de dados, análise e avaliação das atuais e futuras alternativas tecnológicas, com o objetivo de discutir em que circunstâncias o 5G pode ser um viabilizador de novas soluções para melhorar a eficiência do sistema controle de tráfego da cidade e permitir a implementação de estratégias de priorização de modos coletivos e ativos.

## ETAPAS DE TRABALHO

The first part of the study focused on an international benchmarking of several cities around the world, including other megacities such as Istanbul and Bogotá, traffic light equipment suppliers, and universities involved in research on new traffic control technologies. The study formulated criteria for identifying the most promising advances and trends in traffic light and 5G technology, aimed at selecting the most suitable products and the most feasible steps to deploy the equipment to meet São Paulo's requirements. In tandem with the benchmarking activity, a detailed analysis was carried out of the city's extensive traffic light system (continuing the analysis done in the first phase of the Program). This second analysis identified key technological challenges.

33 An intersection is dependent when it does not have a dedicated controller, but is physically colocated and managed by another (independent) unit.

34 Split Cycle Offset Optimisation Technique.

Each traffic light was analyzed according to road size and function, the types of trips predominantly taken in the surrounding area, and the type of hardware and telecommunication infrastructure installed (Figure 15). The recent regulations on 5G telecommunications were also analyzed with a view to guiding future recommendations for the traffic light system, taking into account the incipient deployment of this particular cellular technology in São Paulo.

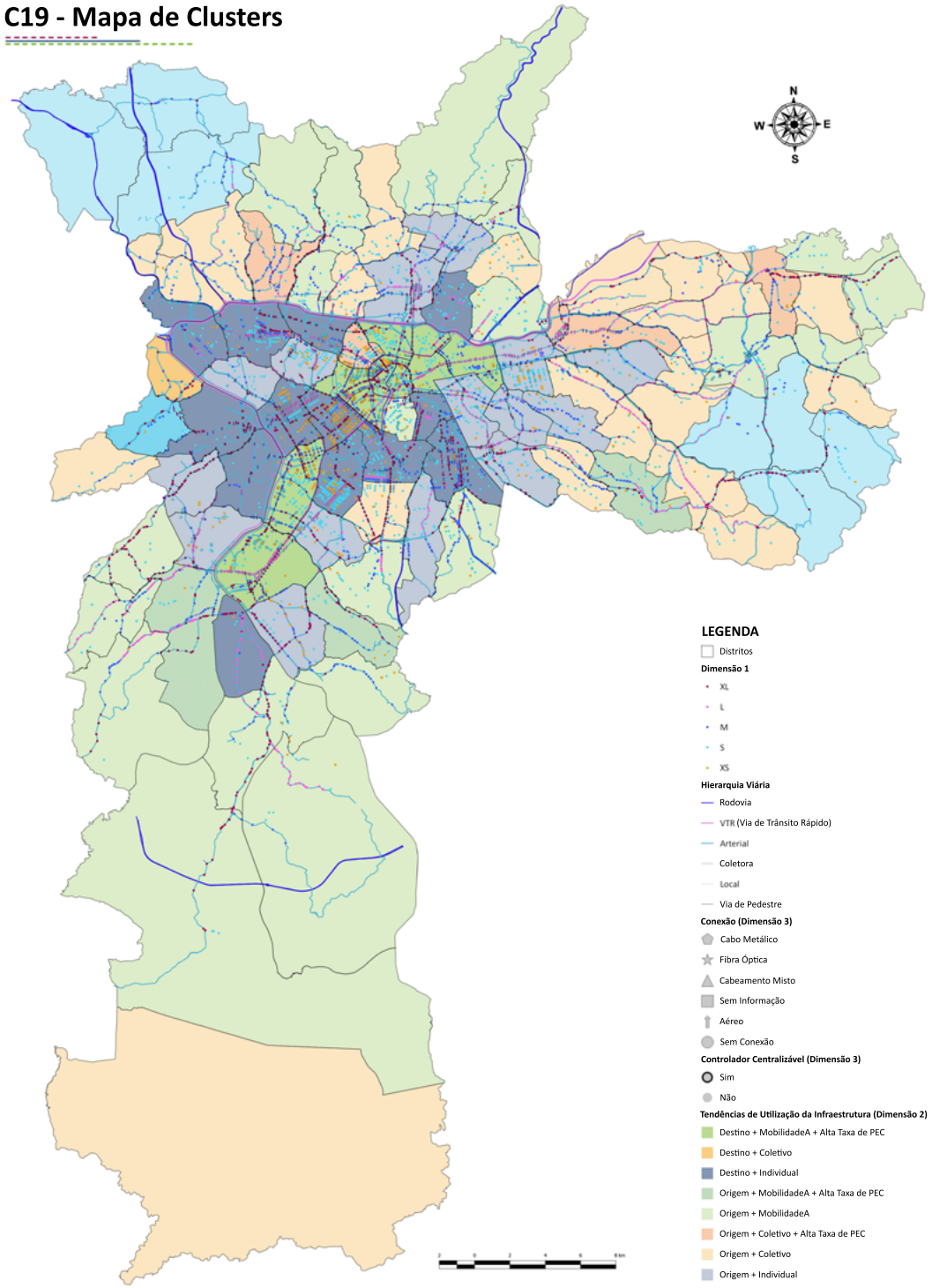



**Figure 15 | Map of traffic light groups. Source: World Bank (2022).**

The next step was to work out strategies for dealing with the different traffic management chal-

lenges encountered, and identify the best technologies available to deal with them. The most suitable for the city of São Paulo were eventually selected based on local characteristics and the need to contribute to improving the most sustainable mobility modes. The approach was implemented using a set of methodological steps to generate a report containing partial results for each of the steps (Figure 16).

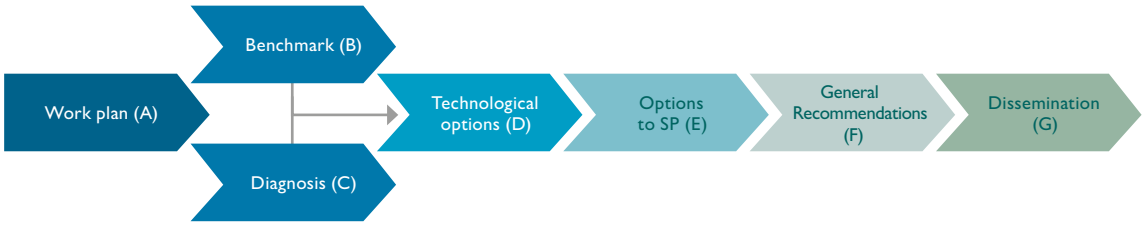



**Figure 16 | Work stages in activity A2.2. Source: World Bank (2022).**

The study took care to analyze the technical-economic feasibility and the cost-benefit ratio of the solutions to ensure they met local regulatory requirements. Suggestions were also raised on possible business models and ways of financing the deployment and operation of each of the steps identified.

## RESULTS

The work strategy determined a set of different scenarios to compare the tasks, costs, risks, and advantages of the solutions examined, pending final recommendations:

i. The first scenario entails the installation of a state-of-the-art traffic control system, including the use of triggered or adaptive controllers using traditional detector systems (loop detectors and cameras).

ii. The second scenario uses wireless sensor technology with static detectors on the road.

iii. The third scenario envisages cooperative smart transport systems (C-ITS) to use vehicles as dynamic detectors, thereby presenting the possibility of designing a hybrid communication architecture.

A hypothetical scenario without controllers was also developed, to give some idea of the scope of future technological advances. The advantages and disadvantages of each of the above scenarios were discussed in detail using a SWOT (strengths, weaknesses, opportunities, and threats) analysis,

followed by a cost-benefit analysis (Table 1) for the first three scenarios (specifically for São Paulo), in order to develop an implementation roadmap with a time horizon of 13 years (Figure 17). The three main aspects identified in the course of the work were:

i. Substitution and relocation of traffic light controllers

ii. Centralization of controllers either via underground cable or a cellphone network

iii. Deployment of specific traffic control strategies

| Cost type | Components | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|---|
| CAPEX | Intersection hardware | 113.463.785 | 55.661.080 | 22.465.465 |
| | Planning and engineering | 26.264.000 | 16.866.000 | 19.922.000 |
| | Communication infrastructure | 8.048.431 | 2.947.316 | 1.081.354 |
| | Cabling | 198.901.879 | 46.205.448 | 114.770 |
| | In-Vehicle infrastructure | 12.355.600 | 6.067.400 | 1.623.800 |
| | Central system | 9.396.000 | 5.684.000 | 10.788.000 |
| | **Total** | **368.429.695** | **133.431.244** | **55.995.389** |
| OPEX | Operation | 3.374.489 | 3.297.190 | 4.625.010 |
| | Corrective maintenance | 12.813.835 | 19.844.958 | 47.736.994 |
| | Preventive Maintenance | 12.813.835 | 19.844.958 | 47.736.994 |
| | **Total** | **29.002.159** | **42.987.105** | **100.098.998** |
| Benefit | Congestion cost | 1.957.718.279 | 740.017.509 | 1.966.332.239 |
| | CO2 cost | 142.337.286 | 79.424.206 | 175.867.884 |
| | **Total** | **2.100.055.565** | **819.441.715** | **2.142.200.123** |

**Table 1 | Detailed costs calculation during the implementation period. Values in Reais (R$). Source: World Bank (2022).**

Note: CAPEX = capital expenditure; OPEX = operating expenditure

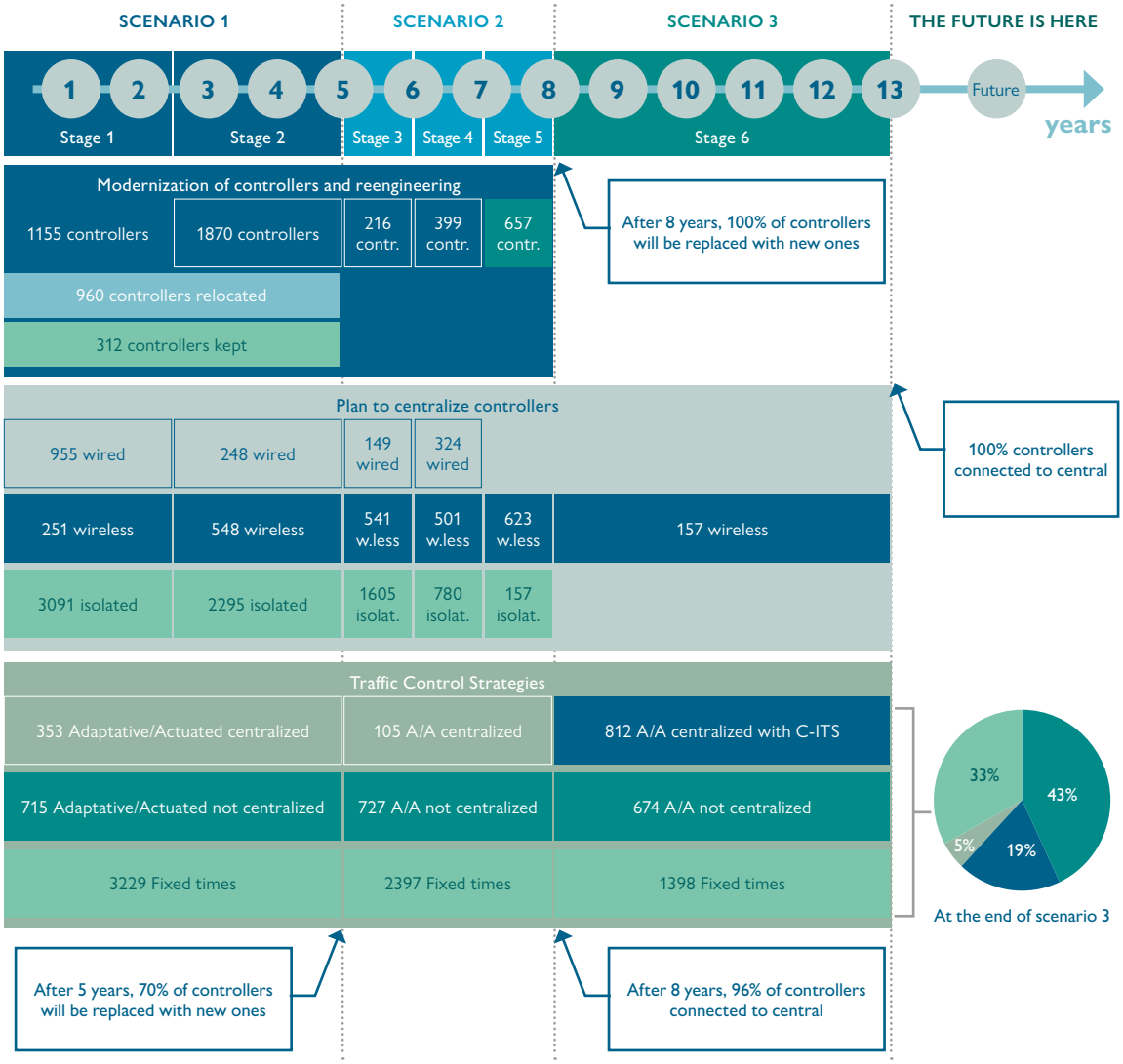



**Figure 17 | Schematic timeline of the Implementation Plan. Source: World Bank (2022).**

Given that the common theme of the entire study was to ensure the cost-benefit ratio and the feasibility of the proposed solutions to meet Brazilian technical and regulatory requirements, possible business models and suggestions on how to finance the implementation and operation of each stage were also identified.

## RECOMMENDATIONS

The main steps needed to implement a traffic management system involving new telecommunications technologies were identified to serve as a reference for other cities:

i. Clarify the client's vision and expectations early on.

ii. Consider all the stakeholders involved, including their roles and responsibilities, their power to influence decision-makers, and so on.

iii. Select and evaluate main influencing factors for the city concerned;

iv. Analyze existing infrastructure, legal, social, political, financial, and administrative/organizational details, existing structures and values, type of travel modes, and so on.

v. Define categories and clusters.

vi. Update benchmarks with available technologies (multicriteria analysis, pros and cons, costs, cost-benefit analysis).

vii. Model possible scenarios;

viii. Undertake feasibility assessment with multicriteria/SWOT analysis, considering visions and goals, prerequisites, and so on.

ix. Identify possible business models and sources of financing and funding, seeking possible technological partners.

x. Formulate an implementation plan, including timeline.

xi. Draft guidelines for future bidding events;

xii. Design a communication plan for improving stakeholder engagement.

xiii. Design of a possible communication plan for stakeholder engagement.

### 5.1.4. ACTIVITY 3: ANALYSIS AND RECOMMENDATIONS FOR THE ESTABLISHMENT OF A MUNICIPAL GOVERNANCE SCHEME IN SÃO PAULO CENTERED ON IMPLEMENTING A MAAS MODEL

#### CONTEXT

The demand for public transport suffered a drastic drop after the COVID-19 pandemic, with many operators facing grave economic problems, a phenomenon that has affected virtually all countries. It is worth noting, however, that changes were already taking place in the way people travel in large urban centers. Over the past 10 years, for example, there has been a steady decrease in the number of transport public passengers. The postpandemic framework has clearly shown the importance of rethinking the future of mobility. The advent of transport applications (apps) for so-called ride-hailing, associated with the spread of vehicle location and routing systems, allows people to acquire mobility services on demand. While public transport has remained largely immune from these changes, there is no way that recent innovations or the impacts of the pandemic can be ignored.

To convert these innovations into excellent public services, a technological leap is needed. Sophisticated digital platforms could be harnessed to realize the MaaS concept. Business models range from keeping all platform management private to full operation of the platforms by public authorities.

In short, MaaS ensures that transportation from origin to destination is a positive and synergistic experience. To realize this, the following elements are needed:

i. An integrated transport system;

ii. A single digital interface that enables passengers to request and pay for travel; and

iii. A facilitator to enable access to ancillary opportunities during travel.

MaaS therefore makes it possible to consult alternative routes, combine travel modes, and consult ticket prices, as well to request, pay for, and map out complete trips using a single interface. MaaS can and should reflect sustainable public policies and serve as a baseline for their proposals. An intermodal trip could combine access to high-capacity public transport systems through public or private, motorized or active, feeder services to be undertaken in comfort and safety. Trips can be monitored from origin to destination, with clear indications of the type and level of the transport services on offer, as well as the different means of payment displayed, accessible and centralized on a single digital platform. Data-informed agreements between managers and operators on the introduction of more integrative public policies will lead to a better user experience for all.

The MaaS platform/application itself is probably the least complex part of the system deployment. More importantly, changes are needed in the current governance regulations of the mobility system, without which MaaS will be simply one more platform likely to have limited significant impact on transport service supply. Institutional changes are needed to increase the levels of integration between the services that already exist in the city, thereby helping to consolidate multi- and inter-modal mobility. At present, formal integrations (e.g., fares and operations) are still very limited and cause inconvenience and delay for the traveling public. Given this context, there is obviously a need for further discussion on how management systems can best support MaaS.

## OBJECTIVES

The study was concerned with governance, focused on the MaaS theme as a way of making public transport more attractive. Implementing MaaS is intended to provide passengers with a high-quality experience as well as strengthen the public transport service as a whole.

MaaS involves all modes of transport and associated services, proposing smart articulation between them, as well as the use of interfaces between system operators and the traveling public. The main objective of this study focused on identifying MaaS components to reflect the specific functions of a potential business unit for managing the system. This unit would form part of the process of delivering passengers from origin to destination.

This study aimed to identify the component of MaaS, considering both the definition of the concept and the steps needed to deploy it. The basic aim was for the PMSP to identify the various themes on which it needed to take action (discussions, consensus building, specifications of mobility services, business modeling, etc.).

A set of indicators to determine mobility flow processes and organization was proposed with a view to creating a reference benchmark focused on two main elements:

i. **Process flow chart** to highlight the MaaS components and their interaction with public sector stakeholders, and transport operators and users;

ii. **Identification of stakeholders that need to be involved in** MaaS operationalization (e.g., concession-granting authority, transport providers and users, and MaaS platform service providers).

## WORK STAGES

Given that MaaS experiences are still at an early stage of development around the world, the work commenced with the preparation of a set of mobility indicators and an international state-of-the-art survey for the  diagnosis and benchmarking activities, respectively.

Indicators specific to São Paulo were developed, together with more general descriptions applicable to other cities. First, data on the city's mobility patterns were consolidated, assessing the regularity of bus transport in the RMSP and capital, describing the characteristics of app-based ride-sharing arrangements, and evaluating bus operators' revenue and contractual challenges. Second, a survey of institutional support and impacts for MaaS implementation was prepared. Any future efforts should consider the involvement of private transport providers, and the need to conform to Brazilian personal data protection regulations.

The MaaS proposal for the City of São Paulo was based on the concept of a "city for everyone," and focused on:

i. Structuring policies related to smart governance and a sustainable, humane, efficient, clean, and safe city.

ii. (2) Analysis and organization: governance, management, operations, and requirements for transport, financial, and user support services. These included the urban mobility process, the governmental and private organizational structure suggested for the efficient operation of MaaS, and a roadmap of initiatives needed to implement MaaS implementation in the City of São Paulo.

General aspects of implementation were also addressed, highlighting different types of strategies, critical points, and risks involved in deploying a smart mobility system for cities around the world.

## RESULTS

The governance study consolidated the proposals for the integrated processes of urban mobility, with emphasis on the component services and trip procedures, the accreditation of stakeholders, and payment and remuneration issues (Figure 18).

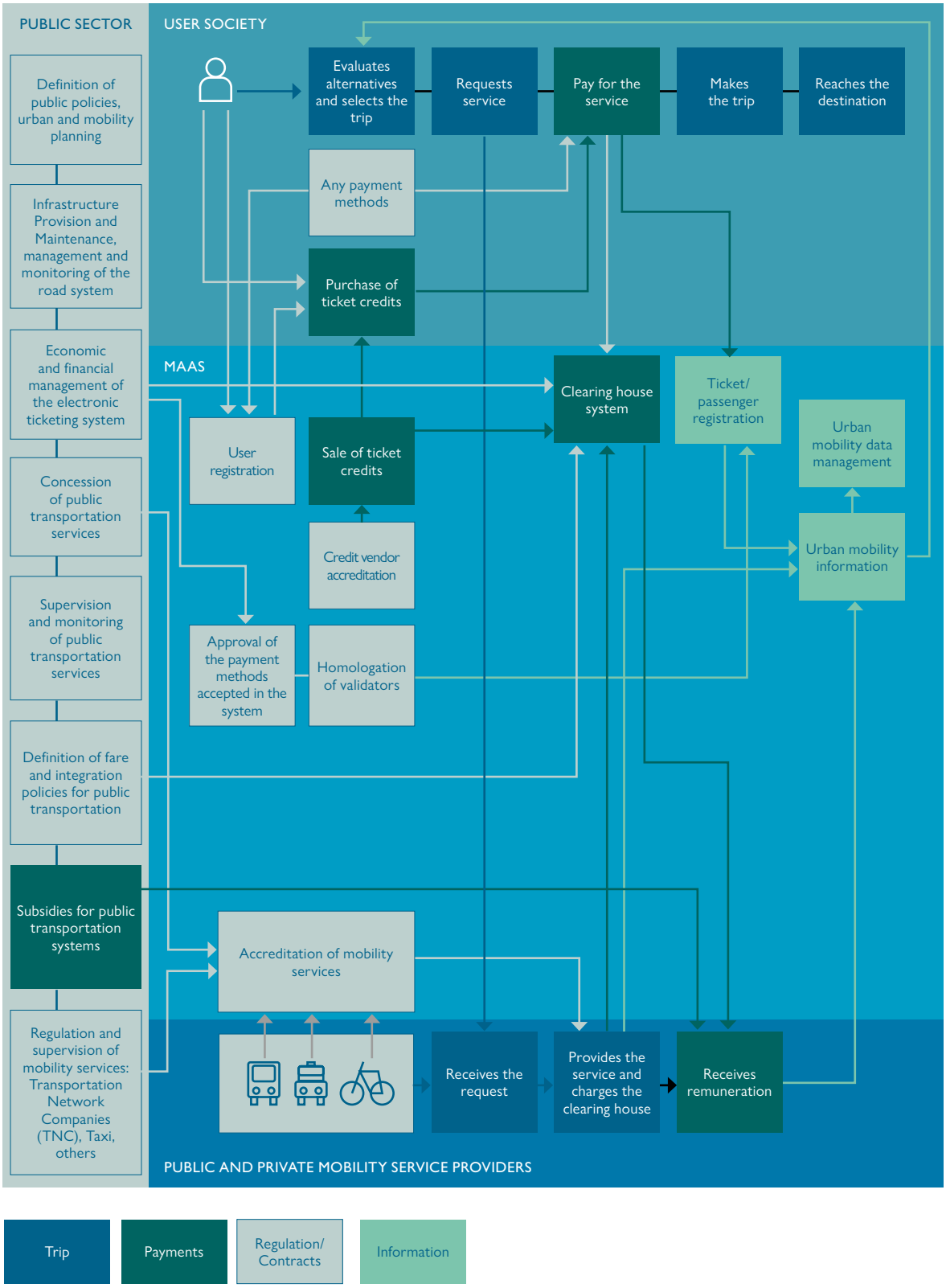



**Figure 18 | Schematic timeline of the implementation plan. Source: World Bank (2022).**

An organizational chart (Figure 19) highlights the roles of the public sector stakeholders involved.

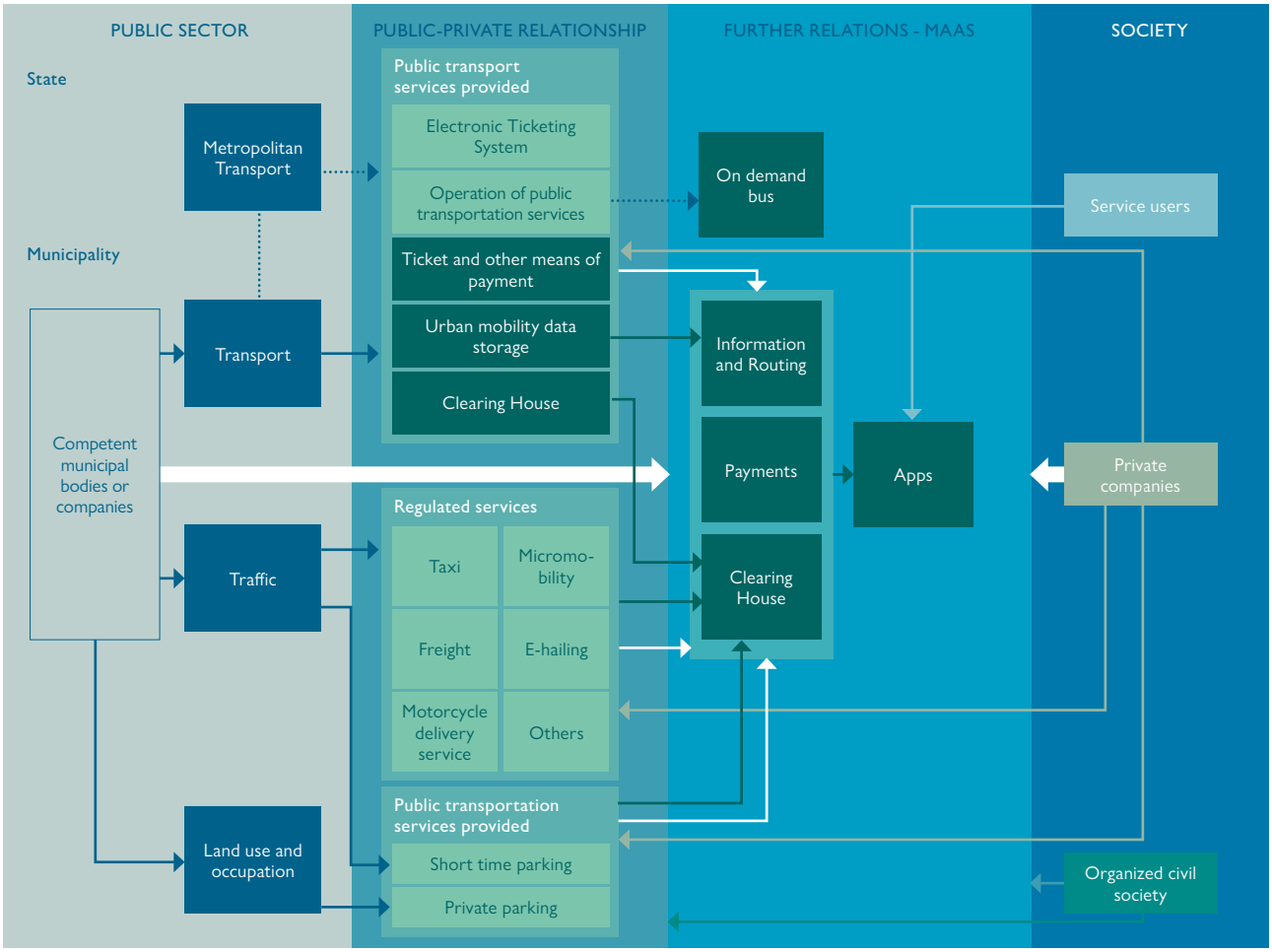



**Figure 19 | Organizational chart of public sector stakeholders. Source: World Bank (2022).**

The study ends with a roadmap outlining the deployment of governance systems for MaaS, aligned with the stages of the theory of change (inputs, technical products, legal products, and expected results) and categorized under four technical themes (tactical-operational, economic-financial, legal-institutional, and digital-technological).

## RECOMMENDATIONS

The study recommends a six-step MaaS deployment process: the introduction of an app, integrated means of payment, integration of public services, demand management, charging for the use of public assets, and full integration, including private services (Figure 20).

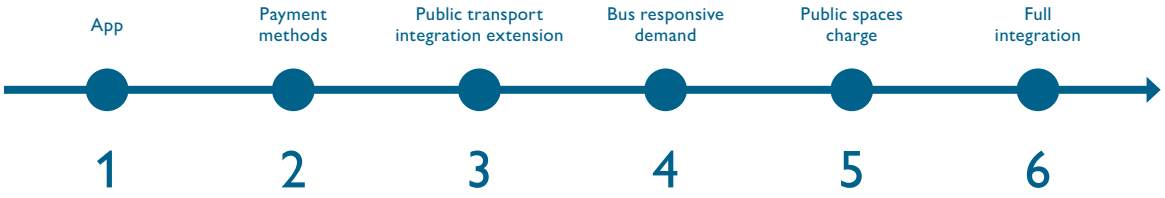



**Figure 20 | Proposed phases of MaaS deployment. Source: World Bank (2022).**

- **Phase 1** centers on an application—a digital platform—through which the user can decide and select a mode of travel, request a trip, pay, and communicate with other stakeholders. A number of alternative providers of this type of ride-hailing app exist. The app could be one of the means for deploying MaaS, which depends on certain public policy decisions to activate it.

- **Phase 2** deals with the set of algorithms to coordinate payment for all the segments of an intermodal trip. It is expected that this payment mechanism will be centralized in an app interface. This stage is highly complex since it requires political decisions about financial operations and safe payment methods.

- **Phase 3** aims to expand the integration of public transport services across the entire metropolitan area, including individual modes such as taxis, bicycles, and so on. A "Park and Ride" scheme is also a possibility (e.g., parking a private vehicle at a point of integration with public transport). Phase 3 generates substantial benefits and would still be fully under the control of the granting authority since it involves only public services and private vehicles, and is therefore not particularly complicated to implement.

- **Phase 4** centers on the implementation of a municipal on demand bus service, to provide the peripheral areas, with less transport demand, a flexible and comfortable service. This could complement the existing local services or even substitute part of those, aiming to benefit both passengers with an adequate service frequency and the providers reduced operational costs.

- **Phase 5** is charging public transport providers or owners of individual means of transport for their use of public infrastructure. This is a complex measure that needs to be conducted in a strategic way. For example, it would be easier to charge urban tolls if, in return, high-quality bus systems were on offer (MaaS itself can contribute to that). A number of fees are already being applied such as those at parking meters or those charged to apps for using a vehicle on a particular stretch of road.

- **Phase 6** is the universal integration of transport modes on the MaaS platform and in public policies. For example, for an intermodal trip requiring a trip to the subway

using an app-contacted vehicle, the user could order the entire trip and pay for it via the MaaS app. Time stamps for entry and exit through turnstiles would also be stored on the app. In addition, app users might be eligible for a fare reduction. The payment methods for this kind of integrated trip still need to be clarified, and the implementation of this kind of complex initiative may be possible only in the medium to long term.

Although the sequence outlined above is recommended in the case of São Paulo, no particular phase has precedence over any other—except for the app phase, which is the vital link on which all the others depend.

In the course of developing this study, it became apparent that the stakeholders central to the integration of urban mobility modes are to be found in various sectors, and not only transport. All require fair and balanced treatment in order to ensure the quality and the environmental, economic, and financial sustainability of transport solutions. Regular communication is key to streamlined processes.

In short, smart mobility is not possible without stakeholder cooperation and coordinated public policies based on good management instruments and continuous monitoring and improvement.





### 5.1.5. ACTIVITY 4: A STUDY INFORMING THE PRIORITIZATION OF EXCLUSIVE BUS LANES IN THE CITY OF SÃO PAULO, INCLUDING MAINTENANCE AND OPERATION

#### CONTEXT

The São Paulo bus system has 131 km of bus corridors, with 565 km more planned. The current corridors mainly comprise dedicated bus lanes. Such dedicated lanes enable increased operating speeds, reduced traffic accidents, and more equal sharing of road space between personal and public transport vehicles. The bus service is organized in three subsystems— structural lines, local regional articulation lines, and local distribution subsystems—across 20 subregions.

PlanMob 2015 (Phases F1 to F4) recommends expanding bus lanes in the city. Phase 1 includes the Aricanduva BRT Corridor, currently at the bidding stage, and other corridors in the east and south of the city, some of which are at advanced project and licensing preparation stages.

The deployment of bus corridors has been delayed due to financial reasons and a shortage of human resources. This study sought to help PMSP set programmatic priorities and seek the necessary investments for advancing the bus corridor program.

Setting up dedicated bus corridors is regarded as an attractive policy to complement other higher-capacity means such as metro and rail systems, which require substantial investments given their relatively inflexible infrastructure and high cost per mile of construction. The City of São Paulo has a great opportunity (and need) to consolidate bus corridors in alignment with key corridors and connected to high-tech terminals. Bus corridors could further much-desired intermodal integration, making a substantial contribution to improving mobility in the city.

## OBJETCTIVES

This study aimed to support the PMSP in formulating criteria to prioritize and identify the investments needed to implement the city's bus corridors program. The study focused on three main goals:

i. Scale up the bus corridor classification system.

ii. Implement a monitoring and control system to evaluate existing bus corridors, prepare plans for prioritizing, and investigate financial resources to invest in the future bus corridors.

iii. Develop a method to support action plans and calculate their benefits by creating a bus corridor dashboard (painel de controle) displaying the city's bus corridors and their role in and contribution to the integrated network.

Given the impossibility of applying the methodology to the complete network of São Paulo's bus corridors, the existing corridors were adopted as a case study. Implementing study recommendations for their upgrading and modernizing promises short-term benefits, including by modeling the proposed methodology.

## WORK STAGES

The following work stages were followed:

i. **Database:** To design a corridor plan, a logical preliminary database was assembled. As work progressed, this database was adjusted to include new data or exclude the old.

ii. **Bus corridor classification methodology:** With the database in operation, a two-step information classification process commenced. These focused on the

dimensions of the corridors (context, physical attributes, operational parameters, and sustainability), and set up three options for each dimension. A number of indicators were selected to assist with the classification exercise.

iii. **Evaluation methodology:** The preceding classification exercise enabled the creation of more complete and specific benchmarks for corridor evaluation. The proposed evaluation methodology considered a corridor to be in good shape when all its dimensions were compatible. A corridor with good physical infrastructure would only be considered "satisfactory" if its full potential was being used. A range of indicators was shortened to a usable list.

iv. **Evaluation:** Based on the demand dimension, targets for physical and operational indicators were set, and expected results and benefits determined, thus enabling priorities to be set for modernizing the bus corridors under study.

v. **Recommendations:** Two sets of recommendations were offered: (i) contracting additional studies for the application of the same methodology along the spokes of a proposed set of corridors; and (ii) considering a new model of bus corridor management, including proactive maintenance to ensure that renovated corridors continue to receive good ratings..

## RESULTS

After deciding on the data to evaluate, evaluations rested on analyses of complementary corridor aspects, and subgroups of indicators related to each dimension (Figure 21).

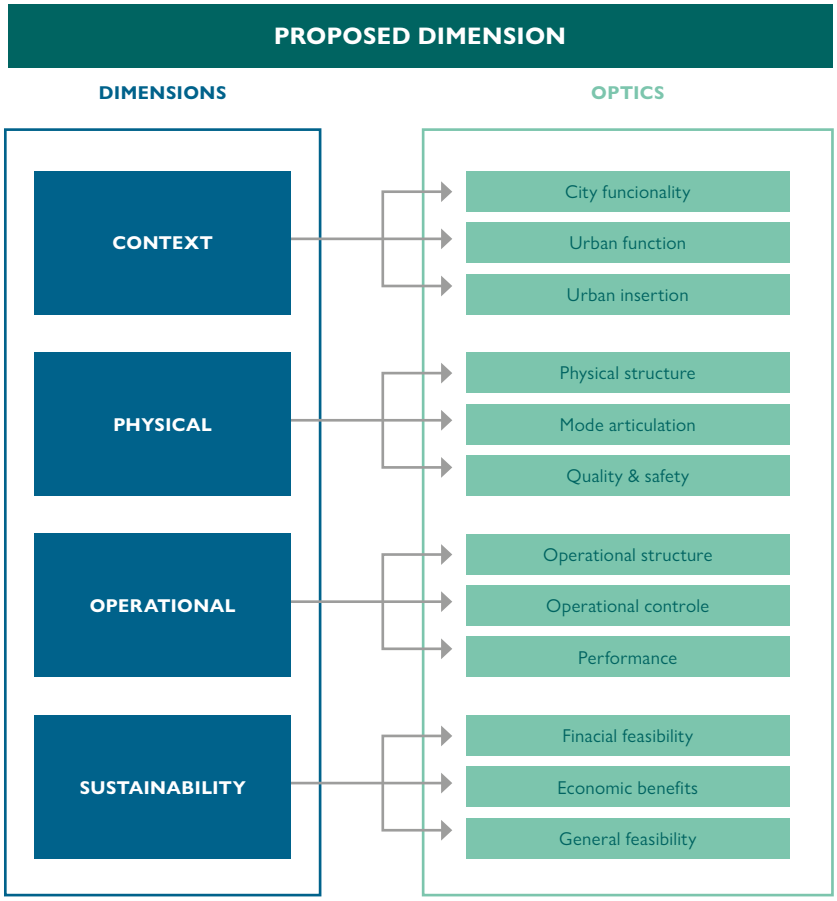



**Figure 21 | Proposed dimensions and indicators for corridors' evaluation. Source: World Bank (2022).**

Corridors were classified and their performance evaluated using a list of indicators in present and alternative scenarios. While the activity focused existing corridors, the methodology is applicable to corridors planned for the future.

Thanks to this study each section of each corridor was classified in terms of its context, physical state, and operational condition. Depending on the imbalance between these dimensions (e.g., good physical condition but poor operational performance in response to a given demand), the corridor was then evaluated, and goals/targets and recommendations for achieving them established.

This analysis was based on a selected list of indicators, tabulated from databases provided by SPTrans. The consistency of indicators was taken into account and recommendations made for adjusting the primary data architecture to improve further evaluations.

The 13 current corridors were evaluated, divided into 69 sections, and assessed individually by directional flow, and jointly by corridor. Data on bus embarkation and disembarkation stops was also evaluated, which meant analyzing around 500 sites. Sections were then prioritized for investment (Figure 22).

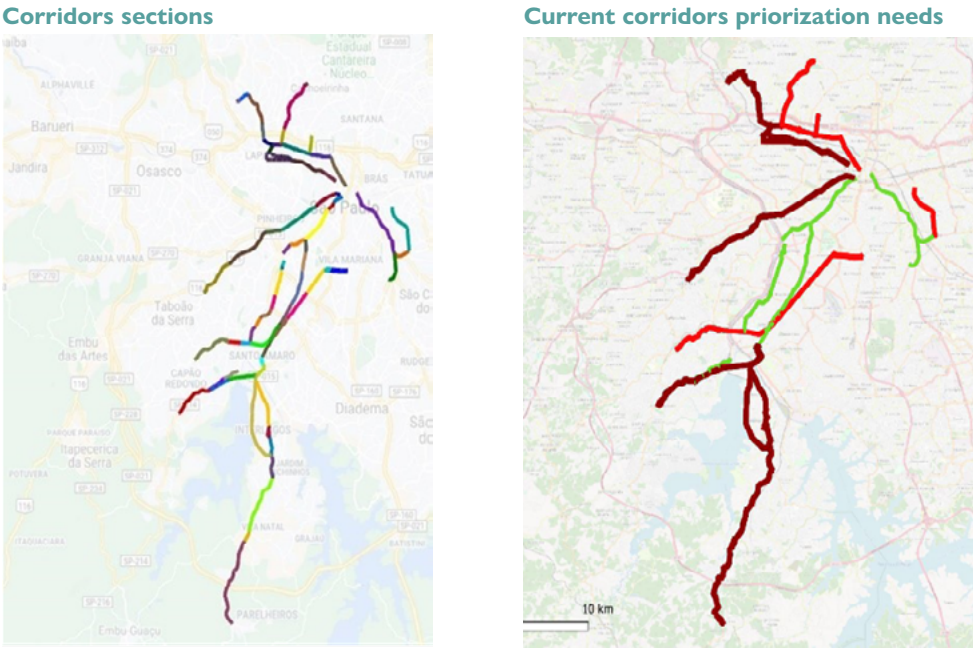



**Figure 22 | Subdivision of corridors for analysis and prioritization. Source: World Bank (2022).**

Note: On the left, the colors indicate analyzed segments of the 13 corridors. On the right, brown = very high priority; red = high priority; and green = moderate priority. The highest priority is accorded to segments with the largest gap between operating conditions and demand.

Diagnostic graphs and evaluations of indicators and benefits were produced for each corridor. For example, the Jardim Ângela corridor was subdivided into three sections, as illustrated in Figure 22. The proposed actions there aimed at improving operational aspects of the scheme.

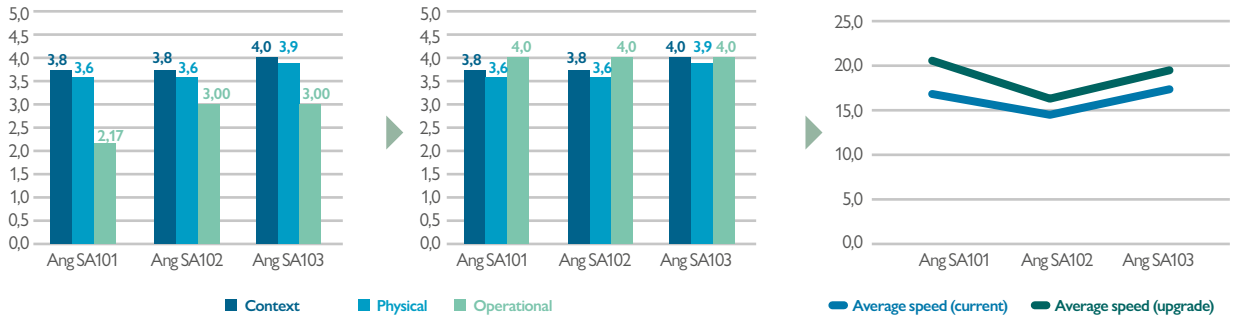



**Figure 23 | Efficiency improvements based on modernization proposals for the Jardim Ângela corridor. Source: World Bank (2022).**

Note: The left-hand graph shows that operational indicators (gray) indicate lower performance than the context and physical indicators, meaning that operational improvements would be sufficient to upgrade this corridor, with no need for physical interventions. The right-hand graph displays operational targets.

The sections of each corridor were numbered sequentially, with the lowest numbers in peripheral neighborhoods and the highest in the urban center. A new series of corridor branches was also recorded, for example, branch 1 sections 101, 102, and 103; branch 2 sections 202, 203, and 204 (in this example branch 2 starts at number 202 because this branch occurs in section 2 of branch 1).

In the case of the Jardim Ângela Corridor, three sections of one branch—101, 102, and 103—were considered. Among the alternatives evaluated, recommendations are listed in Figure 23. In Figure 23, the map on the right illustrates the benefits to be obtained in terms of average speed in the section in the event of the recommendations being accepted and implemented (in practice, there may be benefits in several indicators, but this example shows only average speed).

This process was repeated for each of the 13 corridors. The details of the activity can be found in the final reports. In the table of recommendations for each corridor, the proposed actions are listed in separate lines, indicating impacted dimension, the reason justifying the proposal, the body responsible for implementing the action, the level of priority and, finally, an estimated deadline (Figure 24). Due to the contract schedule of this activity, it was not possible to conduct cost studies.

| Corridor | Dimension of action | Action | Cause | Responsible sector | Priority/ Impact size | Deadline |
|---|---|---|---|---|---|---|
| Jardim Ângela/ Santo Amaro | Context | Increase corridor length (neighborhood direction) | There are more boardings outside the corridor | SPTrans | Medium | Mid-term |
| Jardim Ângela/ Santo Amaro | Context | Incentive to activity use around the corridor | Corridor with high commuting | Urbanism department | High | Long-run |
| Jardim Ângela/ Santo Amaro | Physical | Physical improvement of the stops on section 103 (increase in the number of stop positions, staggered stop, overtaking) | High saturation MBRT (72%) | SPTrans | Medium | Short-term |
| Jardim Ângela/ Santo Amaro | Operational | Lines sectioning, fleet replacement by higher capacity vehicles | High concentration of feeder lines using the corridor | SPTrans | High | Mid-term |

**Figure 24 | Proposed improvements to the Jardim Ângela corridor. Source: World Bank (2022).**

It is worth noting in this example that although the operational dimension is the most unbalanced, contextual and physical improvements are proposed since some indicators did not conform to an average pattern and require further research.

## RECOMMENDATIONS

An action plan was prepared for the current corridors, and it was suggested to scope complementary studies as was done for the current corridors. It was also proposed to carry out an inventory in the field, to be used when examining new investment operations, and as a way of strengthening the studies on the dimensioning and prioritization of new corridors.

As for complementary studies, it is recommended to scope the past use of this methodology to identify the need for balancing context, physical attributes, and operational models. An investment plan can then be budgeted based on this exercise and the resulting proposals.

Finally, a business and contracting model was detailed to include the physical maintenance of the city's main bus corridors, including the avenues within their operational reach. The model also considered attracting private partners to join consortia focused on implementing new corridors or improving existing ones.

The model would form part of a detailed executive project for building the necessary infrastructure and estimating costs of maintenance of the bus corridors. The objective would be to align the proactive maintenance model with the road concession models, adapted to urban areas, and including the possibility of bus operators being responsible for the entire process.

The contract would include, apart from the operation and maintenance of the bus corridor, landscaping and drainage along the corridor as well as maintenance of the road surfaces and of nearby active mobility infrastructure (cycle paths and sidewalks).

A further possibility would be to create contracts that would enable existing passenger transport service contracts to include road surface maintenance for a certain number of years. This model is recommended for São Paulo for the next few years to enable the city to implement corridor projects that will be resilient and remain in good condition for a long period of time.

## 5.2 | PILLAR 2 ACTIVITIES

The activities carried out under Pillar 2 of the Program focused on decarbonization, sustainable mobility, and social inclusion, especially of women and vulnerable groups such as low-income people and those with disabilities.

It is also worth mentioning that certain activities were intended to make the design of the Aricanduva BRT Corridor project more inclusive.

### 5.2.1. ACTIVITY 5.1: TRANSPORT FOR ALL: GENDER AND RACE IN URBAN MOBILITY

#### CONTEXT

Women represent more than half of the global population, but they suffer systematic gender discrimination in cities, including in the RMSP and other Brazilian cities. This is especially true in the case of poorer women. According to the Demographic Census of the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE) women represent 52 percent of the region's population, but reportedly only 12 percent of women receiving minimum wages live close to medium- and high-capacity public transport in the RMSP. This highlights key disparities in transport network coverage. Moreover, from the race angle, the census shows that only 9 percent of black women live near a bus or rail station.

Gender and race are not "neutral" in terms of urban mobility. The transport system is planned and operated regardless of women's needs, especially those of poor and black women. Traditionally the majority of the city's black population has lived on the outskirts, where public transport options are scarce.

#### OBJECTIVES

The study aimed to contribute to the awareness, training, and improvement of the public agencies responsible for planning the public transport system in the City of São Paulo and the greater metropolitan region with a view to reducing gender and racial inequalities in urban mobility.

## WORK STAGES

O trabalho foi realizado em três partes diferenciadas, com foco na perspectiva interseccional de gênero e raça no planejamento, na operação, e na gestão do sistema de transporte.

- The work consisted of three parts focused on the interrelated themes of gender and race in the planning, operation, and management of the transport system.**Planning**: This stage commenced with (1) a survey and analysis of data on the issue of intersectionality in public transport, followed by (2) the mapping and application of semistructured interviews with stakeholders from government, organized civil society, academia, and the private sector, aimed at learning about the current context, and identifying potential future stages of the project. Step (3) involved a workshop to bring together people working on gender and race questions and their links with mobility and the "right to the city," and especially to map the main challenges to integrating these topics into public policies and transport operations. The final phase (4) consisted of focus group discussions with low-income black women who use public transport in São Paulo and three other RMSP municipalities.

- **Transport operation:** This stage involved (1) the identification of good national practices focused on responding to and reducing gender-based violence in the transport system; (2) an analysis and review propositions of the contracts pertaining to the transport system of São Paulo and three other municipalities in the RMSP, which aimed to explain the challenges and the importance of access to transport for women, especially poor black women; (3) the organization of a workshop to explore the best ways to resolve cases and reports of gender-based violence on public transport; and (4) a further workshop to collect inputs for designing a conceptual pilot project focused on complaint protocols and reporting channels.

- **Transport management:** This stage involved (1) an analysis of data on the question of intersectionality in public transport; (2) the identification of good national practices related to the inclusion of women, especially black women, in the transport sector; and (3) organization of workshops with groups and individuals from the PMSP representing strategic areas such as human resources, recruitment protocols, identification of barriers against inclusion, and so on .

## RESULTS

The main finding was that the critical problems for women, especially black women, who use the transport system are overcrowding and gender-based violence.

As for violence, the main victims of theft and muggings are older women. Meanwhile, women in the 20- to 45-year age range report that they fear harassment on public transport from the moment they leave home until they arrive at their destination: on the way to the bus stop, while waiting at the bus stop, while traveling on the bus, and while waiting for a transfer (to use a second, third, or fourth vehicle to finally reach their destination). Most women in this group reported feeling abandoned, helpless, and invisible to other passengers, neglected by the authorities and mobility policies.

## RECOMMENDATIONS

Based on the outcomes of the research on overcrowding and violence, analyses and recommendations were listed under three headings:

i. The planning stage focused on the perceptions of users and stakeholders involved in planning public transport in the City of São Paulo. The objective was to seek a balance between the requirements and concerns of these users and the day-to-day approach of those responsible for planning transport in the city.

ii. At the operational level, we sought to assess how to mitigate cases of gender-based and racial harassment and violence on public transport. The conceptual framework proposed was based on the understanding that actual rates of violence are underreported, and that complaints do not always lead to cases being resolved and punished. The proposal included recommendations for a pilot project to be designed for a unified single protocol to deal with cases of sexual violence on public transport in São Paulo.

iii. From the management standpoint, a diagnosis led to a series of recommendations for establishing policies and measures to attract, recruit, retain, and promote more women, particularly black women, in São Paulo's public transport sector, which continues to be staffed predominantly by white males. To make changes that take into account women's requirements, it is necessary to recruit women to be present and active in the teams responsible for delivering transport services.

The following general recommendations were designed to meet the objectives of reducing gender and racial inequality in mobility:

i. **Implement a single protocol to address women's needs.** This would consist of a set of procedures aimed at reducing acts of sexual violence against women on public transport, by increasing and perfecting complaint registration mechanisms. It is

expected that over time the protocol would help to implement public policies aiming to reduce fear of sexual harassment and rape, reduce gender and racial inequalities, and promote equal access for women, especially black women, to public transport. There is a clear need to involve public bodies at different levels of government to address this problem head-on. An important point is that the involvement of managers of companies, agencies, and other bodies is fundamental to ensuring the success of any measures taken. Senior practitioners need to incentivize, support, and validate actions to ensure that objectives are achieved. Subsequently, it is necessary to create governance for a care protocol agreed on by all interested parties. At present it is vital for some agency or agencies to take the lead in this question, since the problem of sexual violence on public transport is long-standing and complex. What is required is the type of leadership that understands, and is able to assemble, all the existing processes as a prelude to structuring a single protocol. At the same time, indicators need to be created at the strategic, tactical, and operational levels in order to monitor the unified protocol and take decisions based on data and proof. Creating a set of indicators will involve standardizing data collection, undertaking surveys, and publishing transparent data. Finally, the unified care protocol should be regarded as a prototype. Using products developed under the Transport for All (Transporte para Todas) project, the team responsible for preparing the protocol should define the technologies and data monitoring platforms to be used, and select and operationalize the appropriate indicators for monitoring and evaluation.

ii. **Research perceptions of comfort, overcrowding, bus stop conditions, wait times, and transport reliability, highlighting gender and race issues.** These can be used to inform standards related to fleet size and the frequency of bus transport outside rush hours. Given the routines and user profiles of women who use public transport there is a need to focus more on these off-peak times. It is also important to ensure that buses are available at night and during the early hours of the morning when safety considerations are uppermost on women's minds (with the possibility of buses stopping on request). It is possible to incorporate these questions in the performance indices contained in some of the operational contracts analyzed.

iii. **Introduce bus features to ensure comfort and universal accessibility**, such as a lowered floor to facilitate boarding and disembarking, preferential seats, and bus stops with a minimum of comfort and convenience. The requirements must also go hand in hand with targets for vehicle upgrading.

iv. **Promote the use of equipment for monitoring and controlling crimes and attacks against women**, and install mechanisms for reporting sexual harassment, discrimination, violence, and other crimes.

v. **Promote the implementation of training programs for drivers, ticket**

**collectors, and other public transport employees** to raise awareness and teach them how to deal with cases of sexual harassment and violence against women.

vi. **Determine the implementation of communication channels and "help centers" for women,** comprising multidisciplinary teams of female social workers, psychologists, and lawyers at bus stations and other terminals. These centers are needed to support and provide assistance to women, principally those suffering sexual harassment and other types of violence.

vii. **Deploy long-term campaigns against sexual harassment** in public transport, developed with the participation of organized civil society.

viii. **Open access to georeferenced databases containing information on cases of violence and sexual harassment, disaggregated by the gender and race of the victim, type of violence, and so on.** Ensure that women's defense social organizations, especially those focused on black women, play a role in the conception and implementation of decisions referring to transport network/line changes, and other decisions referring to planning and structuring public transport concessions and operations.

ix. **Collect operational data and undertake user satisfaction surveys disaggregated by gender, race, class, age, transport mode, time of the day, and factors linked to users' perceptions of safety.**

x. **Determine indicators to support the monitoring of efforts to reduce inequality, promote social inclusion, and improve access to the services provided by concession operators,** to be incorporated into the "quality" indices defined under the respective contracts. In addition to indicators and metrics, it is important to create responsible for analyzing and monitoring gender- and race-related data. Furthermore, since all the requirements and indicators relating to women's issues need to be followed up with fines and mechanisms for ensuring compliance, it is necessary to include in the contract clauses defining fines, penalties, and contingencies reports of specific events linked to women's needs. It is also necessary to determine lines of responsibility and intervention in order to establish progressive and quantitative goals for ensuring gender and race parity among staff working for the transport companies, at different levels of the organization, and perhaps to consider some kind of bonus for companies that achieve their stated goals. It is of course also important for companies to have clear guidelines on the procedures to be follow in cases of discrimination and violence against women, including black women, in the work environment.

The following are the **key recommendations** required to ensure that the issue of intersectionality between gender and race is taken into account by **managers of the São Paulo public transport system:**

i. Investment in training courses for women.

ii. Internal programs of inclusion and creation of quotas for black women, mainly in activities traditionally carried out by men.

iii. Procedures to identify aspects of discrimination and to develop affirmative and awareness-raising actions.

iv. Extension of black women's contract provisions to include third-party companies and suppliers.

v. Contractual requirements to raise awareness of gender and race issues among senior managers by inserting appropriate clauses in contracts.

vi. Formation of committees to suggest actions for improving policies for black women, and addressing gender issues in general.

vii. Training of senior managers in the role of women in the workplace.

viii. Efforts to prepare women to assume senior management positions.

ix. Broadening the debate on racial and gender equity to include bus companies.





### 5.2.2. ACTIVITY 5.2: MAPPING OF SAFETY AND ACCESSIBILITY AROUND THE ARICANDUVA BRT CORRIDOR

#### CONTEXT

The Aricanduva BRT Corridor is located in a low-income and socially vulnerable area of São Paulo, with more than 1.2 million inhabitants, including 29,000 families living in urban slums (World Bank 2020). Studies carried out during project preparation showed that the poor quality and lack of maintenance of urban infrastructure in these places affect residents' quality of life and increase urban violence. Low levels of public lighting and crumbling sidewalks instill a sense of fear in women, who often walk home after disembarking from a bus. Against this background the study, conducted through Safetipin, collected data on

safety and accessibility in the area proposed for the BRT corridor in Aricanduva, with a view to learning about possible barriers to the use of the new infrastructure, and proposing improvements to its design.

## OBJECTIVES

The key objective of the study was to collect data on the possible barriers affecting women's perceptions of their own safety, and to survey other possible barriers to the use of public transport or access to future terminals in the catchment area of the Aricanduva BRT Corridor. The findings of focus group discussions (FGDs) and interviews contributed to improving the design of the BRT corridor and its surroundings in terms of safety and mobility, as seen from women's standpoints. Finally, recommendations for making the Aricanduva corridor safer for women were developed.

## WORK STAGES

The study covered the following activities.

i. Project planning—definition of the study area along the 14 km length of the BRT corridor in each direction, with a buffer zone of 800 meters on each side of the corridor.

ii. Data collection—image collection, FGDs, interviews with experts and decision-makers, an assessment of selected bus stops and their access routes.

iii. Data coding and analysis—focused on geotagged photos and the information collected in the FGDs.

iv. Final report—results of the data analysis, recommendations, dissemination of project findings among stakeholders.

## RESULTS

The study used both quantitative and qualitative tools to identify the factors that impact the daily mobility of women. Safety mapping using the Safetipin app highlighted gaps in the area's infrastructure, such as poor lighting and sidewalks, that prevent women from being at ease on public transport and in public spaces (Figure 25). The mapping also sought to understand how the social environment around the corridor affects women's mobility. This set of quantitative data was complemented by qualitative data from

the FGDs with bus users in the Aricanduva region. The FGDs were a useful tool for acquiring deeper knowledge on the mobility patterns of women, and their experiences of fear, discomfort, and insecurity when accessing and using public transport.

The study also involved interviews with key local government practitioners to obtain their views on gender and mobility and the perceptions of their role in enhancing women's security. The findings of the Safetipin app and FGDs highlighted the need for a more comprehensive evaluation of three sections of road near to the Aricanduva corridor.

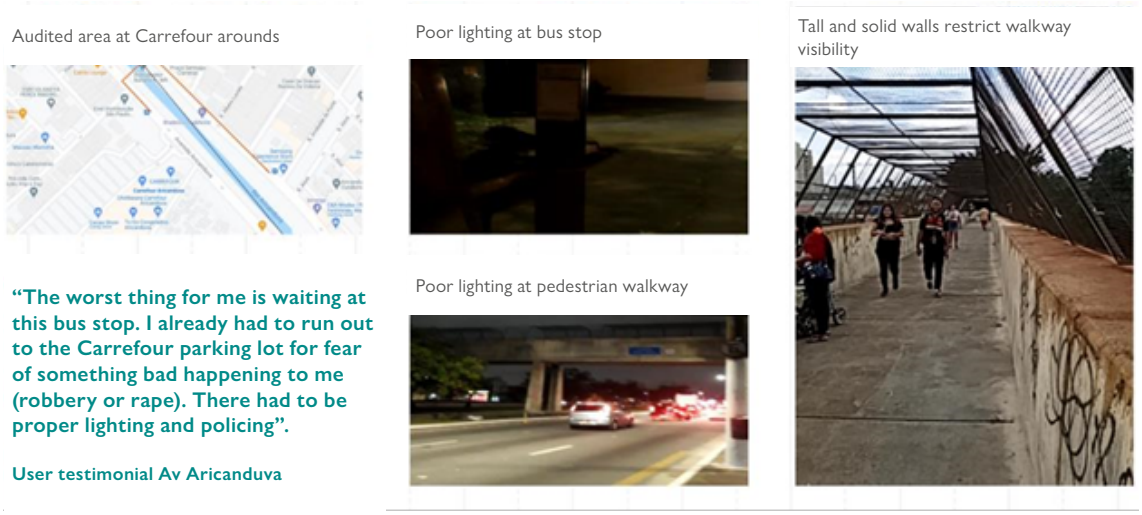



**Figure 25 | Analysis of area with inadequate lighting on the footbridge over the Av. Aricanduva. Source: World Bank (2022).**

The assessment established a direct correlation between the availability of infrastructure and services and women's sense of insecurity in and around public transport. The study clearly shows that a lack of inclusive and gender-oriented urban services and infrastructure is a barrier to women's mobility, preventing them from accessing opportunities that will promote their development and overall well-being. The report concludes with general recommendations to improve the safety and accessibility of women near bus stops.

## RECOMMENDATIONS

Given the outcomes of the study, it would be advisable to pay special attention to the routes that women have to walk between the planned corridor and existing bus stops, as well as improvements to the infrastructure of these stops. These improvements are essential for the BRT project ensure the inclusion of women in the area.

The results and recommendations can be used to define a strategy for including gender issues in projects to upgrade the city's transport infrastructure, especially that of the urban bus network. SPTrans plans to apply the study's methodology to other areas of the city to improve women's access and perceptions of safety to bus stops.

### 5.2.3. ACTIVITY 5.3: INDICATORS OF GENDER INCLUSION AND ACCESSIBILITY OF BUS TERMINALS IN THE CITY OF SÃO PAULO

#### CONTEXT

São Paulo has 32 bus terminals serving different bus lines. The related infrastructure in different areas of the city affect activities beyond public transport. The terminals will be leased in different batches, with the PMSP aiming to significantly improve users' access and perceptions of safety. One possibility would be to include some obligatory improvements and use of performance indicators in the concession contracts for the terminals as a way of guaranteeing the inclusion of vulnerable groups.

In the course of preparing the various concessions, the PMSP requested the support of the World Bank team to develop an analysis and monitoring tool assessing the current and future status of terminals once the concessions have been granted, as well as the impact of improvements on the inclusion of women, persons with disabilities and reduced mobility, and the elderly.

#### OBJECTIVES

The study aimed to (1) define a protocol for analyzing and monitoring the inclusion of groups of interest; and also (2) prepare indicators to identify a baseline and record the impact of improvements and investments over time.

#### WORK STAGES

The project included the following activities:

i. (1) Development of data collection tools for the analysis and monitoring of terminals:

   a. Questionnaires to collect perception data of bus station users.

b. Roadmap for gathering ethnographic data on bus terminal users, identified as the groups of interest for the project.

c. Checklist for a technical audit of the security and accessibility of infrastructure.

ii. Development of a set of indicators to measure the impact of investments and actions carried out by PMSP to make terminals more inclusive.

iii. Implementation of data collection tools and indicators in two terminals.

iv. Analysis of results and review of the performance of tools and indicators.

v. Adjustments and finalization of tools and indicators and the preparation of a manual to aid replication in other terminals.

## RESULTS

The Cidade Tiradentes (east area) and Cachoeirinha (north area) terminals were selected as pilots for the deployment of the indicators and tools: 410 questionnaires were filled out by regular users of the Cachoeirinha terminal, and 418 from the Cidade Tiradentes terminal (Figure 26). In addition, 13 sets of ethnographic routes data were gathered, 7 at the Cachoeirinha terminal and 6 at the Cidade Tiradentes terminal. The ethnographic tool was applied to 25 users of the terminals analyzed. Two short videos on these activities were also recorded.


**Figure 26 | Access to Cidade Tiradentes and Cachoeirinha terminals. Photos taken during field data collection. Source: World Bank (2022).**

The checklist and audit were applied to both terminals, where 144 security and universal accessibility items were evaluated. The audit was carried out by two trained technicians, who recorded the data collection exercise in the field with photos and videos to be used later for an in-office audit review.

The resulting data informed 17 gender inclusion and accessibility indicators for São Paulo's bus terminals. The indicators were assembled into four large groups ("key indicators") to measure the following items:

- User perception and demands
- Services and maintenance
- Functioning and usability
- Infrastructure

The methodology initially developed for assessing the indicators was modified in agreement with PMSP practitioners, to bring it roughly into line with other available control and follow-up mechanisms. The results confirm the usefulness of the tools developed for monitoring terminal characteristics that influence the inclusion of women, people with disabilities and/or reduced mobility, and the elderly.

Bus terminals are important hubs of activity for local residents. More than 50 percent of respondents confirmed that they used the terminals for activities beyond public transport. The main responses related to the use of public toilets (16.4 percent at the Cachoeirinha and 18.9 percent at the Cidade Tiradentes terminal), the bus terminal as a safe meeting point to wait for friends and/or family members (11.3 percent Cachoeirinha, 14.2 percent Cidade Tiradentes), and enjoying a meal (18.1 percent Cachoeirinha, 12.7 percent Cidade Tiradentes).

Regarding the safety perceptions of terminals, more than half of the interviewees (56.3 percent in Cachoeirinha and 50.2 percent in Cidade Tiradentes) judged the security to be sufficient. Interviewees who indicated that security needed to be improved said that they felt most unsafe on the access routes to the terminal (19.4 percent in Cachoeirinha and 25.9 percent in Cidade Tiradentes) or when walking around inside (12.2 percent in Cachoeirinha and 15.9 percent in Cidade Tiradentes). As for the accessibility of the terminals, the main barriers were access routes (21.8 percent in Cachoeirinha and 24.2 percent in Cidade Tiradentes).

Obtaining the results of the indicators involved the evaluation of 115 items in each terminal. To facilitate this exercise, an average score was assigned to each of the factors, groups, and indicators. In this way, the maximum values are close to the value 2 (two) and the minimum values will be close to 0 (zero).

Table 2 presents the results obtained for the terminals in terms of indicators and groups.

| **Indicators/Groups** | **Terminals** | |
|---|---|---|
| | **Cachoeirinha** | **Cidade Tiradentes** |
| **A. Users' perception and demands** | **1,37** | **1,43** |
| Security perception outside the terminal | 1,74 | 1,74 |
| Security perception inside the terminal | 1,13 | 1,00 |
| Accessibility assessment | 1,24 | 1,57 |
| **B. Services and maintenance** | **0,69** | **0,59** |
| Maintenance | 1,25 | 0,90 |
| Available services | 0,83 | 0,88 |
| Record of incidents | 0,00 | 0,00 |

| Indicators/Groups | Terminals | |
|---|---|---|
| | Cachoeirinha | Cidade Tiradentes |
| **C. Operation and usability** | **1,46** | **1,16** |
| Ticket purchase/recharge | 1,88 | 1,48 |
| Orientation inside the terminal | 1,00 | 1,00 |
| Other uses | 1,50 | 1,00 |
| **D. Infrastructure** | **1,17** | **0,99** |
| Access route from abroad | 1,04 | 0,92 |
| Terminal access | 0,88 | 1,00 |
| Indoor circulation | 1,08 | 1,00 |
| Information and communication | 1,00 | 1,00 |
| Boarding platform | 1,88 | 1,00 |
| Furniture elements | 1,00 | 1,00 |
| Public toilets | 1,33 | 1,00 |
| Public toilets[35] | IND | 1,00 |
| **Group average** | **1,17** | 1,04 |

**Table 2 | Results of user surveys regarding two bus terminals. Source: World Bank (2022).**

The figures in Table 2 indicate that:

- The Cachoeirinha terminal has a rating closest to 2, as seen in groups 7, "Ticket purchase/recharge" and 14, "Boarding platform," both with 1.88.
- At the Cidade Tiradentes terminal, the highest positions were group 1, "Security perception outside the terminal" (1.74) followed by the group 3, "Valuing accessibility" (1.57). Both values were obtained from the application of tools to obtain the perceptions of users of the bus terminals.

35 Emergency Evacuation cannot be included in the calculation of the Cachoeirinha terminal due to lack of values.

- The comparison between the results obtained in the two terminals reveals lower values for the Cidade Tiradentes terminal in most of the groups corresponding to the infrastructure technical audit.

- Indicator B, "Services and maintenance," is closest to zero for both terminals. Among the groups evaluated in this indicator, number 6, "Registration of incidents," has a value of zero given the nonexistence of facilities for registering incidents and complaints.

- The findings justify the need to carry out improvements in and around the terminals, especially regarding the services available and the lax security along the access routes.

The study findings may be used in internal presentations aimed at sharing the tools and indicators with other municipal departments and with the operators responsible for running the bus terminals.

## RECOMMENDATIONS

The analysis of the Cachoeirinha and Cidade Tiradentes terminals reveals that all the aspects evaluated need to be addressed with specific action plans to improve their performance. These plans must also take into account the access routes and the immediate surroundings of the terminals.

The varied uses of the terminals must be taken into consideration when improvement actions and investments are being developed. Apart from providing public transport, other amenities at the terminals are worth examining, such as parking spaces for buses, snack bars, and public restrooms.

The lack of means for terminal users to register incidents and complaints calls for the need to establish communication channels. The tools proposed to construct the indicators can be one way of evaluating user perceptions and identifying their needs and priorities in each terminal.

The terminals under study are similar in terms of spatial layout. Taking into account the existence of different layouts in the remaining terminals, sharing the tools and indicators model may require adapting or amplifying the items evaluated in the safety and accessibility checklist and audit.

As for the indicators, some of the inputted items were of particular importance. These items could compromise safety and/or accessibility questions evaluated, regardless of the final result from the indicator weighting. For this reason, a recommendation was made to the city to consider prioritizing, when preparing the new bus terminal concessions, actions and investments designed to improve universal accessibility and safety.

### 5.2.4. ACTIVITY 6.1: URBAN LOGISTICS: USE OF CURBS AND ALTERNATIVE MODES FOR EFFICIENT FREIGHT DELIVERY IN SÃO PAULO

#### CONTEXT

Measures to contain the transmission of COVID-19 increased demand for last-mile-focused freight transport. Isolation and social distancing and the closure of nonessential services altered consumer habits and increased demand for delivery services. For example, in a less than a year of the pandemic, e-commerce revenue had risen by around 50 percent. This was accompanied by an increase in the number of motorcycles on the streets, along with a significant increase in traffic accidents and fatalities. While the annual growth rate of the car fleet in the MSP fell between 2019 and 2021, the growth of motorcycle numbers remained constant at 4 percent.

Meanwhile, cyclologistics has become a topic of much discussion in recent years, given the contribution by cyclists to promoting sustainability in a mobility area traditionally used by vehicles running on fossil fuels—motorcycles, vans, and trucks. In 2020, São Paulo created the Municipal Cyclologistics Policy through Law 17.322/2020 to encourage the use of bicycles in urban freight and parcel-handling operations.

#### OBJECTIVES

This study focused on developing three working groups of stakeholders from different areas such as academia, industry, shipping, logistics, the public sector, and other entities, with the following goals:

i. Structure a pilot project and recommendations optimizing the use of curb space by urban freight transport.

ii. Structure a pilot project and recommendations for the use of alternative modes of transport in the urban freight handling sector.

iii. Recommend legislative initiatives to enhance urban freight transport efficiency and consider improving data sharing with the use of modern technology.

#### WORK STAGES

The working groups focused on the three key themes related to last-mile cargo delivery issues: (1) curbside management and sharing, (2) the use of alternative modes of delivery, and (3) legislation and technologies that impact the logistics sector.

Different activities were carried out to identify the challenges faced by couriers in using of curbs. Data were collected, for example, on the perceptions of delivery people and recipients regarding the delivery system. Also, surveys were carried out in two areas of the city to map the loading and unloading activities of commercial establishments.

Regarding the use of alternative delivery modes, the working group sought, through simulations, to evaluate the impact of the use of vehicles such as bicycles and cargo bikes, in two logistics operations networks. This analysis also included the evaluation of "forward bases" (logistics operations closer to the destination area in which the cargo is transferred to smaller, more flexible vehicles for delivery to the final recipient) at freight distribution points in the city. The exercise included the preparation of a manual for creating cyclologists pilot studies for São Paulo (also useful as a benchmark for other cities).

For the final stage of the study, discussions were held with an expert on cycling regulation in cities. A baseline survey examined the main legislation and regulations in force and under development with a view to identifying opportunities, the need for adjustments, and recommendations for the next steps.

## RESULTS

### i. Curb use

The results obtained by the first working group indicated that the management and sharing of curb space, often disputed by different groups and individuals in cities, mainly in mixed land use areas, can serve to provide exclusive lanes for active mobility modes such as walking and cycling, as public space in front of shops, as fee-based residential parking spaces, or for curbside deliveries.

The surveys revealed large numbers of delivery trucks stopped in inappropriate places, near the curb or even on the sidewalks. In a poll of delivery people, 24 percent of respondents admitted to using the curb for short-term parking (under five minutes). Respondents also reported individual passenger vehicles parking in spaces intended for loading and unloading. One explanation was a lack of available parking spaces and inadequate turnover at parking meters.

The limited number of parking spaces for deliveries causes congestion, accidents, and pollution. In addition, the need for delivery drivers to park in distant locations undermines efficiency, safe handling of goods, and increases overall travel times.

One step is to reevaluate the demand for parking spaces, taking account of the number of parking places in an area, road and street characteristics, number of parking fines, and so

on. This would not only inform planning but also make it possible to conduct a preliminary analysis of dynamic pricing.

#### ii. Alternative modes

The simulations were also conducted for the use of bicycles and cargo-bikes for last-mile deliveries. Collaboration between shippers reduces the total distance traveled. However, the financial sustainability of operations depends on scale, to reduce fixed costs. A *Cyclologistics Pilot Manual* was developed based on international examples and best practices.

### RECOMMENDATIONS

Recommendations for planning spaces, pricing, and functionalities of the "Zona Azul" rotating parking service, and the public use of private parking places for loading and unloading, featured better coordination between deliverers and recipients.

The importance of considering cyclologistics when planning cycling infrastructure was also highlighted. The main recommendation was to conduct a survey of bike courier companies and couriers to identify the difficulties faced by both.

The last working group made general recommendations for broadening the discussion on the logistics of the transport sector. One recommendation was to engage different stakeholders in the transport sector by creating a Technical Committee focused on urban logistics, and a data-sharing platform for urban freight transport.

The *Cyclologistics Pilots Manual* was created in collaboration with CET and shared with PMSP and SMT in the expectation of deploying future pilot projects jointly with potential logistics partners, as well as organizing a Cyclologistics Day and a Demo Day in partnership with the UK government.

## 5.2.5. ACTIVITY 6.2: ANALYSIS OF SHARED SPACE IN THE CITY OF SÃO PAULO

### CONTEXT

The poor distribution of road space, which prioritizes individual motorized modes (cars and motorcycles), results in inefficient urban mobility systems that contribute to sociospatial inequalities. Studies

on the per capita road space occupied by each mode of transport, for example, reveals that each car passenger occupies up to eight times more space on public roads than a bus passenger. If the Brazilian vehicle fleet continues to grow at an annual 7 percent, the number of vehicles would double every 10 years, while at only 2 percent a year it would take 35 years to double the length of the road network. This imbalance between traffic supply and demand calls for strategic planning. Mobility Demand Management (MDM) strategies are probably the most viable in the long term.

In general, MDM strategies combine economic measures (command, regulatory, physical, and operational) to promote desired changes in travel preferences. These measures can serve to vary the timing, destination, or mode of travel, thus leading to more sustainable travel patterns. Combined with the Complete Streets (Ruas Completas) concept, the strategy could potentially shift people from the use of individual transport modes toward more sustainable modes, by redistributing the road space to provide more space for pedestrians, bicycles, and public transport, and limiting the space for automobiles.

## OBJECTIVES

The study analyzed the use of the current road system in the MSP by different modes of transport in order to establish a MDM strategy to promote greater equity in its use. The main objective is to support the MSP to implement public policies to promote active and public transport and take steps to discourage the use of cars, by: (1) determining public policies that could generate changes in travel behavior; (2) assessing the cost -benefit ratio of deploying these measuresto reduce the negatives externalities related to transport; and (3) recommending regulatory and investment measures to improve sidewalks, and increase space for pedestrians.

## WORK STAGES

The study was developed in four stages:

i. **Benchmarking** data on several cities around the world that have successfully implemented measures to change their modal distribution. Measures adopted in São Paulo, and their impacts, were also analyzed.

ii. **An analysis of the distribution of road space in MSP** compared to demand from different transport modes. This enabled an estimate of the costs of negative externalities to current mobility patterns in the MSP (congestion, emissions, accidents, noise, occupation of urban space).

iii. **A simulation of road space redistribution** measures and policies to evaluate changes in user behavior, impacts on travel times, and the potential for modal shifts.

iv. **Action plan and roadmap** for the effective deployment of public policies aimed at better distribution between modes in the city, focusing on two actions: micro urban interventions and improving the walkability of sidewalks.

## RESULTS

The benchmarking exercise revealed that several cities around the world have adopted vehicle restriction measures by imposing traffic circulation or emission fees, urban tolls, rotating parking payments, and other restrictions on vehicles entering cities (Rodízio, Pico y Placa, etc.). In São Paulo, exclusive bus corridors and lanes were implemented, together with restrictions on the circulation of cars using the license plate scheme (Rodízio) on alternate days and restricting parking on public roads through direct charging (Zona Azul) or simply restricting the number of parking spaces. Other measures, such as congestion charges, have not been implemented in the MSP, despite being the subject of much debate.

Although the Rodízio scheme was intended to reduce congestion in the city, it had the undesirable side effect of encouraging drivers to acquire a second vehicle, often an older, more polluting, vehicle. In 2019, around a quarter of traffic violations in the city were due to noncompliance with the Rodízio rules (2.4 million cases), suggesting that individuals appear willing to pay to use their car despite running the risk of being fined. This was adopted in Cali (Colombia) when drivers who chose to enter the central area of the city on disallowed days and times were required to pay a fee. The city already had the "Pico y Placa" policy since 2005, and in 2017 it also adopted a congestion fee (Taxa de Congestionamento), allowing vehicles to be driven in the entire urban perimeter on "restriction days" upon payment of a charge. The urgent need to locate alternative sources of funds to finance the BRT scheme was the trigger for the adoption of this measure (95 percent of congestion fee revenue in Cali is earmarked for the BRT).

As for interventions aimed at prioritizing active modes in complete streets, there are several successful cases, such as Pontevedra in Galicia (Spain), New York City, São Paulo, and Barcelona. Redesigning streets to encourage pedestrians and cyclists confirmed the concept that managing travel demand is the first step toward a more balanced redistribution of modes of travel. In Pontevedra, the first policy action that became internationally known was the ban on vehicular traffic in the city center in 1999—the local government's first year of office. This low-cost measure led to a series of urban infrastructure changes that resulted in the Metrominuto—a communication strategy to encourage the city's population to walk.

An analysis of road space redistribution in the MSP revealed great disparities in road space use by different modes of transport. Around 60 percent of the road space in the MSP is dedicated to gen-

eral traffic, mainly cars and motorcycles occupying approximately 10 times more space than public transport (6.5 percent). Taking only exclusive bus lanes into account (2.9 percent), this difference is 20 times. The total surface of sidewalks amounts to 32 percent, but when considering the areas not available for pedestrians (occupied by trees, lighting poles, etc.) and the minimum desirable standard stipulated by PMSP in the Manual of Urban Design (1.80 meters for pedestrian movement), only 12 percent of road space are suitable for walking.

This distribution of supply contrasts with the modal split of travel demand. A third of trips are by individual motorized transport, which takes up two-thirds of road space. On the other hand, public transport, which corresponds to the second third, occupies only 6 percent of the space. The last third of trips are made on foot using the 12 percent of space suitable for walking. Based on the ratio between the road space used by each mode and the respective number of daily trips, at one end of the spectrum trips by private car and motorcycles (plus taxis, school buses, etc.) occupy 13.6 $m^2$/daily trip. At the other extreme is public transport, which occupies 10 times less road space: 2.3 $m^2$/trip (or, counting only exclusive bus lanes, 0.7 $m^2$/trip). The area suitable for pedestrians also contrasts with public transport, at 4.3 $m^2$/trip. The large portion of public space devoted to automobiles is effectively a subsidy for individual private transport users who pay no additional taxes or contributions, while the entire cost of road maintenance ends up being paid by the PMSP.

Apart from being a far less efficient use of public space, individual motorized transport is the main reason for negative environmental and social externalities, such as congestion, traffic accidents, poor air quality, and GHG emissions. Cars and motorcycles contribute three times the daily GHG emissions in the MSP compared to municipal and intercity buses (75.4 percent vs. 24.6 percent). In the case of atmospheric pollutants, buses are responsible for a pollution cost of R$7.9 per 1,000 km, motorcycles for R$17.3, and cars R$1.5. The city is home to around 6 million cars, 2 million motorcycles, and less than 50,000 buses.

Congestion is another result of intensive car use. Commuting time would be reduced by nearly half if traffic flowed freely. It is estimated that 45 percent of the total duration of trips is caused by delays. At late afternoon rush hour, these make up 56 percent of total trip time. An aggravating factor is the additional time that car drivers inflict on public transport users, since bus passengers often spend an average of 20 percent more time (26 percent at peak times) on congested roads. As for traffic accidents, motorcycles are responsible for the highest average aggregate costs, totaling an average annual cost of R$263 million, followed by cars, with an average annual cost of R$240 million. Meanwhile, accidents involving buses and trucks generate average annual costs of R$53 million and R$ 32 million, respectively.

A simulation in the eastern area  of the MSP showed that around 6 percent of current car trips could be made by bicycle and 46 percent on foot. Walks are typically under 1 km or between 1 km and 3 km, while bicycles are used for intermediate distances (from 1 km to 3 km or from 3 km to 6 km) or even longer journeys (6 km to 10 km). The simulation revealed that the redistribution of road space, with restricted capacity for cars and more space for buses, bicycles, and pedestrians, could lead to a 19 percent reduction in car trips, thereby saving R$1.25 million per day.

## RECOMMENDATIONS

The recommendations of this study focused on São Paulo, reflecting the limitations and possibilities related to improving management and providing alternative financing for the city's sidewalks. Sidewalks and dedicated bicycle lanes are the key to transforming public spaces while simultaneously responding to the urgent challenges created by climate change and the need to foster public health.

The study revealed that public management of sidewalks in the city is a highly segmented process, reflecting the specific interests of stakeholders involved. This evidence points to the urgent need for public sector practitioners to consider the provision, maintenance, and repair of sidewalks. Numerous municipal bodies, for example, CET, the subprefectures, the Green Secretariat (Secretaria do Verde), and so on, possess specific powers and functions to deal with sidewalks. The absence of an effective decision-making body and a lack of internal procedures for developing projects and implementing roadworks are disincentives for taking action to improve the city's sidewalks.

The question of managing sidewalks in the city also involves understanding the interface between the government and citizens regarding their individual responsibilities to maintain sidewalks, in cooperation with the public sector authorities. The study examines the information channels available to citizens in relation to sidewalk maintenance and the PMSP's current inspection and sanctions procedures. The study points to a number of possibilities for strengthening the role of public management in terms of guidance, awareness raising, publicity, and encouraging residents to help maintain public pathways.

Finally, given the extent of the dilapidated sidewalk infrastructure and the urgent need to increase investment in sidewalks, the study identified a range of financing sources. This included looking at urban planning measures such as urban intervention involved in the provision and transformation of built space, and tax measures to contribute to improving public works, especially those related to road safety such as the program in Area 40 (São Miguel Paulista). Similarly, mapping was carried out of municipal funds (for example, the Urban Development Fund [FUNDURB] and the Municipal Transport Fund), originating from former activities to improve the city's environment, and from partnerships with the private sector. If such resources were eventually tapped, priority should be given to active mobility. Despite the difficulties arising from the country's current economic situation, the study unearthed a number of promising opportunities and ways forward.

## 5.2.6. ACTIVITY 6.3: MICROACCESSIBILITY MANUAL.

### CONTEXT

Infrastructure deficiencies and poor accessibility, mainly in the peripheral areas of the City of São Paulo, make it difficult for people to access job opportunities, activities, and essential goods and services, perpetuating socioeconomic inequalities.

Microaccessibility can be defined as the ability to access a particular place at the urban micro level near areas with services and public transport. This is a right that benefits everyone, including the vulnerable segments of the population such as those with permanent or temporary disabilities, the elderly, and so on. Microaccessibility is, therefore, a fundamental element in addressing inequalities and making the city more inclusive.

### OBJECTIVES

This study aimed to provide technical support to the PMSP in the design of urban interventions focused on improving the city's walkability and accessibility conditions. The *Microaccessibility Manual* developed in this study contains practical solutions for urban environment interventions aimed at including everyone in the public space, promoting greater security, autonomy, freedom, pride, and representativity. The manual is intended to be used in urban planning and design projects associated with mobility plans, public transport routes, residential neighborhoods, and community amenities (clinics, schools, and shopping and service centers).

### WORK STAGES

Os conteúdos apresentados são o resultado de três tarefas, que compreenderam:

i. A survey of "microaccessibility";

ii. Development of solutions; and

iii. Preparation of a pilot plan for an irregularly occupied area in the City of São Paulo.

The first activity included a review of the literature and the concepts, benefits, and practical ap-

plications of microaccessibility. A review of 16 national and six international technical references provided a list of solutions to be included in the manual and applied in the pilot project.

The Microaccessibility Manual is based on an understanding of the relations between individuals and public space, focused on functional, gender, age, and racial diversity. It is essentially a list of project recommendations for addressing active mobility systemically in urban interventions and providing practical solutions to enhance microaccessibility in, for example, the peripheral areas of the city where narrow streets, irregular occupation, and rugged topography make walking extremely difficult. Figure 27 illustrates one of the proposals included in the manual.

A pilot proposal was prepared for the Guaicuri area in south São Paulo. The area was suggested by PMSP, which is already running projects that could potentially benefit from urban microaccessibility solutions.

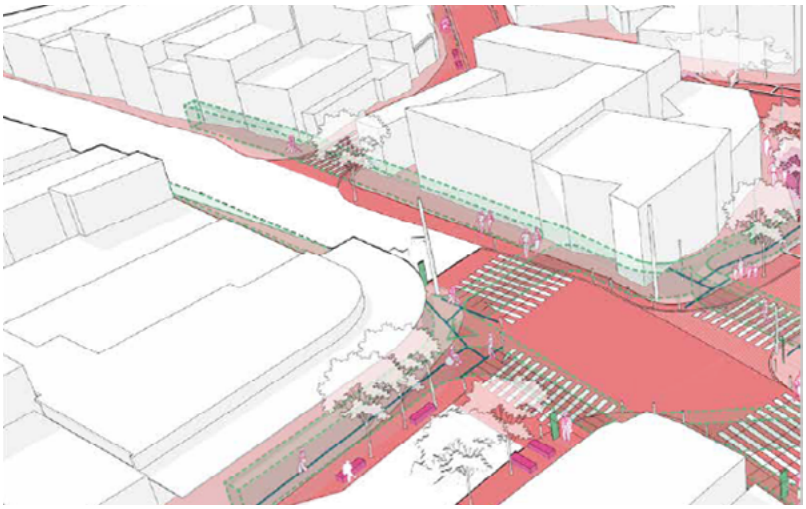


**Figure 27 | Proposal included in the Microaccessibility Manual. Source: World Bank (2022).**

## RESULTS

The proposed tools and methodology seek to build microaccessibility networks to facilitate solutions for traditional urban plans and projects, as well as autonomous initiatives. The method provides initial guidelines for structuring microaccessibility networks and projects and for involving local communities in the process with a view to exchanging information with groups and individuals as part of an interactive and continuous learning process.

The guide comprises four steps: (1) defining the theme; (2) tracing the microaccessibility network; (3) applying the principles of microaccessibility; and (4) consolidating the process. It also contains guidelines on the structuring process, examples of interventions, communication tools, and recom-

mended ways of engaging with the local community. The interventions described include accessible pedestrian routes, integrated sensory information system, tactile information, accessible routes for walking, and the humanization of public space.

One of the interventions presented is the "Free Tunnel" support tool (Figure 28) for ensuring continuous, safe, and accessible mobility for pedestrians through an imaginary obstacle-free tunnel consisting of an easy-to-view tool that highlights walkable paths virtually as a way of ensuring that these are accessible, integrated, and continuous.

**Figure 28 | "Free Tunnel" support tool for planning pedestrian access. Source: World Bank (2022).**

## RECOMMENDATIONS

To develop proactive, integrated, flexible, and long-term urban plans and projects, the political debate on microaccessibility networks needs to be broadened. Planners need, for example, to be fully aware of the context in which actions will take place and to prioritize the groups and themes that are most relevant to the city. The first step is to identify the demand for urban accessibility and active mobility prior to designing integrated networks to facilitate mobility on foot. Subsequently, plans, projects, and existing initiatives must be analyzed, followed by a definition of problems within the context of the city as a whole or of the intervention area concerned so that interested stakeholders can be mobilized. Finally, it is necessary to define the focus of working groups and studies according to each set of topics addressed.

The design of a microaccessibility network requires surveying and mapping socioeconomic scenarios. Tasks include analyzing information on transport networks, population density, areas of social vulnerability, topography, availability of public communities, housing zones, and the number of jobs in a given area of interest. Analysis includes mapping areas frequented by pedestrians, and identifying the functionality of a particular route. Maps of physical and sensorial barriers may be informed by survey respondents' safety perceptions, experiences of thermal and acoustic dynamics in certain areas, and sense of belonging to a particular public space.

The technical recommendations in the Microaccessibility Manual may be used as reference examples for urban projects in peripheral areas, where processes involve many and varied stakeholders. It is

essential for local residents to engage with the changes occurring in their space resulting from the deployment of a plan or project. Residents must therefore be informed of what is happening, and project operators must be prepared to exchange information and knowledge with residents by organizing workshops and activating different channels of communication.

### 5.2.7. ACTIVITY 6.4: SUPPORT FOR PLANNING CYCLE LANES IN SÃO PAULO

#### CONTEXT

Cycle lanes in the MSP have a long history dating back to the 1980s, but have taken on more importance over the past 10 years due to the increased number of people using bikes as a form of transport. Between 2013 and 2016, around 480 km of new cycle paths and lanes were deployed in the city, representing a milestone in the history of cycling planning. However, OD 2017 data reveal that despite the growth in cycling infrastructure, the use of bikes in the modal mix of the City of São Paulo is still fairly minimal, accounting for a mere 0.9 percent of trips originating and finishing within the MSP. This lower-than-expected figure is the main motivation for the present study, which explores the main factors that encourage or discourage people from choosing bikes as a mode of transport in their daily lives, in an effort to find solutions that may be incorporated in the city's cycling plan.

#### OBJECTIVES

The main objective of this study was to provide technical support to PMSP in the analysis of barriers to bicycle use, by collecting data on cycling and cyclists and preparing recommendations to support decision-making on complementing, developing, and deploying new infrastructure to promote the use of bikes as a common mode of transport in the coming years. The study focused on prioritizing the expansion of the cycling network in order to improve existing cycling facilities, meet current demand for this kind of travel, and attract new bicycle users. The study also makes recommendations for designing bicycle lane infrastructure, and expanding the shared bicycle and bike rack system in the MSP.

#### WORK STAGES

The study was developed in three stages:

i. Diagnosis of the cycling system, including an analysis of the current network, an analysis of

potential demand based on the Cycling Potential Index, and three field research surveys.

ii. Recommendations for reviewing the cycleway plan, including recommendations for prioritizing the design and expansion of networks.

iii. Analysis of the economic benefits of increasing the use of bicycles in the city, leading to a reduction of the direct costs and negative externalities caused by individual motor transport.



## RESULTS

The bicycle network in the City of São Paulo includes 667.1 km of bike paths and fixed cycle lanes and 32.1 km of designated cycle routes. Added to the 140 km network already planned,[36] the future consolidated network would cover 3.35 percent of the MSP road network (23,000 km). By way of comparison, the Santiago (Chile) network has 6.3 percent and Bogotá 7.6 percent of road network coverage. The analysis showed that the future network will still have several "missing links"—105 subnetworks not connected to one another.

The people near bike lanes (PNB) indicator[37] shows that 30 percent of the population of São Paulo lives less than 300 m away from the cycling network. However, the same indicator, segmented by race and income, reveals substantial inequality in this distribution. For example, white people have 13 percent more access to the existing cycling network, while black people have 23 percent less access in relation to the mean. Households with a monthly per capita income below or at minimum wage have 26 percent less access, while families with an income triple that of minimum wage have 46 percent more access. The greater concentration of the network in the expanded center of the city results in unequal access for black and low-income users, which could be alleviated by expanding the network in peripheral areas.

As for travel demand, about 23.5 percent of the total daily trips to and from the City of São Paulo could be done on bikes. Of the 23.62 million trips made by car, motorcycle, public transport, and on foot, some 5.5 million could be made by bicycle.[38] Regarding intermodality, of the 3.5 million in-

36 The 140 km are part of the 300 km of new structures planned to be implemented by 2024 (Targets Program 21/24 - Final Participatory Version 2021). Available at: <https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/governo/arquivos/programa_de_metas/programa-de-metas-2021-2024/pdm.relatorio.versao.final.participativa.pdf>

37 Created by ITDP, the People Near Bike Lanes (PNB) indicator measures the percentage of the population that has easy access to cycling infrastructure for circulation—in this case, what percentage of the population lives within 300 m from the deployed network.

38 This analysis was based on the Cycling Potential Index, a methodology applied and adapted in different cities around the world as a tool to support decision-making in the context of cycling planning. Potential cycling trips were those trips observed in the 2017 OD Survey that meet criteria such as the socioeconomic profile of current cyclists, slope criteria, and distances between 1.25 km and 7.5 km. Looking at each mode, it can be seen that 37 percent of car trips in the municipality could be made by bicycle, as could 25 percent of bus trips.

termodal trips in which the first leg of the journey is to a train or subway, approximately 1.1 million (31 percent) could be done by bike. Five hundred thousand trips to subway or train stations are made on foot (24 percent of the total), meaning one-quarter of journeys on foot are made over relatively long distances to public transport hubs. As for motorized travel modes, 600,000 access trips to metro-railway transport are potentially cyclable, but are made using motorized transport. Of this total, 500,000 trips were by bus, representing 39 percent of the feeder trips by bus.

**Quantitative research**[39] indicates that 45 percent of bike trips seek to avoid public transport, while 23 percent are to save money. For more than 90 percent of bicyclists, the main criteria for choosing a particular route are lighting, safety, and available cycling infrastructure. These criteria were even more significant for women. Fear of robberies, assaults, falls, and being run over in traffic appear to be the main inhibitors of bicycle use among noncyclists. This group stated that if cycling infrastructure existed on the route to their main destinations, they would consider using a bike. Those who use bicycles frequently seek to reduce commuting time, and to exercise and improve their quality of life, especially on trips where the bicycle is more competitive in terms of travel time and cost.

The **bikeshare system** also appears to be important, mainly due to the flexibility that the system provides throughout the travel chain. Bike sharing has a strong appeal for people who also use public transport but have to travel distances to access it. Both groups, current users or not, highlighted the importance of network connectivity and continuity. For nonusers, being able to cycle from origin to destination seamlessly (i.e., without "the bike lane ending nowhere") is a major consideration.

## RECOMMENDATIONS

After assessing the city's cycling network and gathering the views of bicycle users and nonusers, this study proposes expanding certain parts of the network to attract the greatest number of new users in the short term. The proposal would involve the addition of 233 km to the current network by 2028 (in addition to the 140 km proposed by CET for the year 2022 (Figure 29). Of this total, around 103 km connect missing links and another 130 km expand service to the periphery. Addressing the missing links would significantly increase the number of zones connected to one another (from 221 to 272) and reduce the number of subnetworks (from 110 to 56).

Expanding service out to the periphery would lead to an increase in the number of people near bike lanes and businesses near bike lanes (this last share would grow from 65 percent to 71 percent of

39 Three surveys were carried out on the cycling mode, namely: (1) two focus groups with users and noncyclists; (2) a quantitative survey of a sample of 1,000 respondents; and (3) a stated preference survey. The research aimed to identify the main barriers and motivators behind the use of bicycles and, consequently, indicate opportunities to promote everyday bike travel.

businesses in the catchment area), effectively shortening the gap between home and work. Moreover, it would reduce inequality in access to the cycling network. In the case of the black population it is estimated that GNP inequality would be reduced from -24 percent to -17 percent. The same result would apply to the very-low-income population. It is worth noting, however, that improving the accessibility of the cycling network will probably not affect people who have to travel for work, given that many jobs are concentrated in more central areas of the city. An increase in access to schools and other educational institutions, especially in the east and southwest of the city, could lead to more bike use among students.

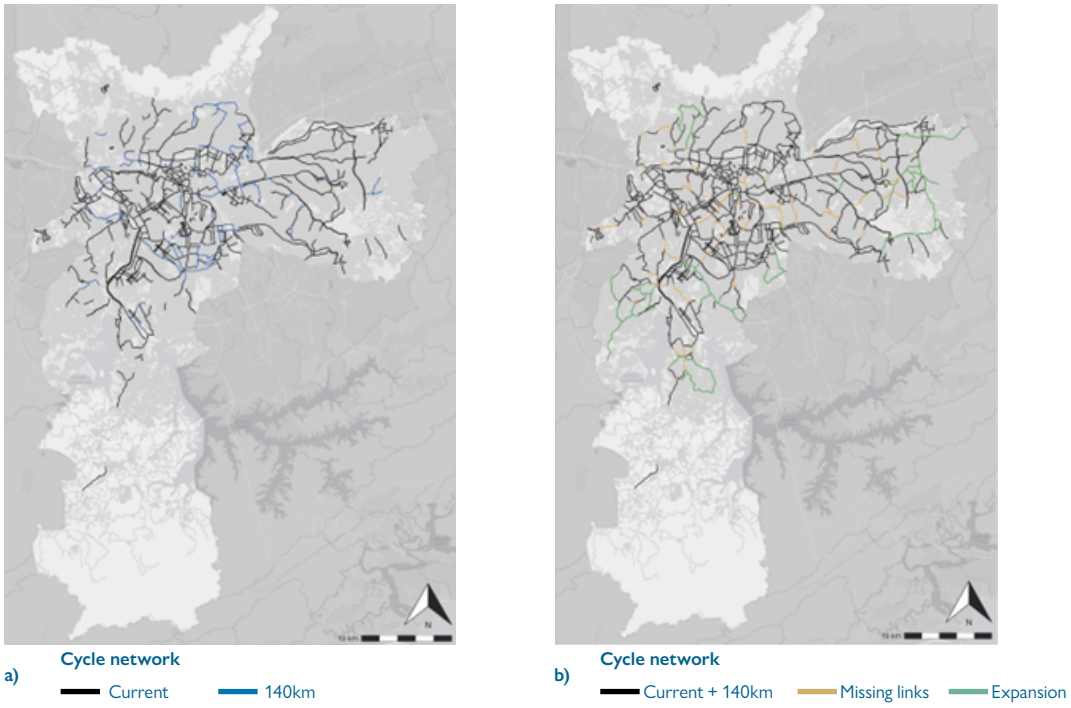



**Figure 29 | a) Current cycling network + 140 km; b) Proposed prioritized network. Source: World Bank (2022).**

Note: km = kilometer.

Careful design and planning are needed to achieve a **connected, convenient, and safe cycling network**. Even a few centimeters' increase in the width of a lane, for example, can benefit cycling infrastructure. The city possesses robust policies, statutes, and general laws consistent with the key principles of cycleway infrastructure projects. However, it is clear that these principles are not always reflected in cycleway design. There is, in short, an important opportunity to improve the network from a technical, design, and implementation standpoint.

A **benchmarking study on bike-parking business models** made it possible to identify

bike-related activities such as rentals and/or ancillary activities similar to those operated by the Bike-Hub group in San Francisco, California (the United States), at Caltrain stations and as part of the BART system. Useful models for regional bike racks (not linked to public transport) include the Puntos de Encuentro in Bogotá, Colombia, and electronic subscription-based bike racks, such as those in London (the United Kingdom) and San Francisco. Encouraging private car parks to accept bicycles as part of their services, as in Bogotá, would help to significantly increase the supply of bike parking spaces. Other suggestions would be to employ security personnel to caretake bike parking places in city bus terminals, as provided for in the bus terminals' public-private partnerships.

### 5.2.8. ACTIVITY 6.5: SAFE AND ACCESSIBLE SCHOOL ROUTES FOR CHILDREN

#### CONTEXT

This study provides input for the PMSP programs "Educational Territories" (Territórios Educativos) and "Safe School Routes" (Rota Escolar Segura), proposing alternatives for accessibility and mobility challenges for all children, particularly those with disabilities. In this context, the study complements the Safe School Routes Program in Peripheral Regions, developed by the PMSP, by suggesting improvements to the routes taken by children and their caregivers on the way to school and highlighting specific issues, such as the need to ensure the safety of vulnerable groups making their way from one place to another, and in the long term guaranteeing a better life in general for the inhabitants of urban areas.

#### OBJECTIVES

The project aims to use data to identify the needs and opportunities for improving accessibility to schools, and so on, for children, their caregivers, and the low-income population in general. Based on these data, the project aims to develop knowledge and expertise on universal accessibility solutions focused on children living in vulnerable areas, based on São Paulo's "Rota Escolar Segura" program developed by CET.

#### WORK STAGES

The project included the following stages:

i. Solution benchmarking: an analysis of accessibility solutions for children successfully applied in other cities and countries, to serve as a benchmark for the study, and a desk

review of relevant literature.

ii. Identification of challenges and needs:

- Secondary data analysis for the selected schools.
- Identification of challenges and needs:
  - Interviews with prominent activists and decision-makers.
  - Organization of four workshops with stakeholders.
  - Involvement with the local community through participatory activities.

iii. Recommendations for inclusive access to schools:

- Development of action plans with proposals for solutions.
- Incorporating the subject of accessible urban mobility in the school curriculum.

iv. Validation of recommendations.

v. Dissemination.

## RESULTS

During the benchmarking stage, solutions were studied to improve the mobility of children and their caregivers previously developed in different cities with similar characteristics as São Paulo. This made it possible to identify compatibilities in terms of the challenges and lessons learned.. The stage for identifying challenges and needs, already completed, focused on Vila Carmosina and Vila Campestre. This choice was based on indications by PMSP practitioners, and information obtained from existing data and databases. Information on traffic accident rates that occurred near schools in the targeted neighborhoods

was supplied by the GeoSampa open database.[40] Using the 2019 school census it was possible to identify the number of students with disabilities (physical, intellectual, hearing, multiple, low-vision, blindness, deafness, and deaf-blindness) in each of the selected neighborhood schools.

The next part of this stage included an analysis of the selected areas aimed at identifying challenges and opportunities. The process included:

- An assessment of secondary information and open data, and the development of a methodology for collecting information in the field to assess conditions in the environs of the selected schools.
- In-person and virtual participatory activities from June–August 2022, in line with the engagement strategy agreed to between the parties. The activities included virtual workshops with the participation of public agencies, members of civil society, and the selected schools in Vila Carmosina and Vila Campestre.

Surveys in the field sought to identify current conditions and critical points that impact children's safety on their way from home to school and back. One of the main objectives of the fieldwork was to evaluate how different users view the roads in terms of safety, convenience, and accessibility. The fieldwork included counting motor vehicle and active mobility flows, mapping activities, observing accessibility at crossing points, collecting data on behavioral and environmental factors (vehicle speed, noise pollution, air quality monitoring, etc.), and preparing a simplified geometric survey.

The measurements were taken at 10 different points located on routes around the schools of Vila Carmosina (5 points) and Vila Campestre (5 points).

Engagement cycles were organized with a view to formulating a set of activities based on needs:

- Cycle 1: present the project to focus groups and map the needs, difficulties, and gaps in projects and processes that address the question of safe and accessible school routes.
- Cycle 2: assemble focus group participants with a view to facilitating the sharing of experiences, and the highlighting of good practices and solutions to reflect local circumstances.

40 The Geosampa portal's georeferenced data on the City of São Paulo include about 12,000 urban facilities, the public transport network, geotechnical maps, and important data on the population, such as population density and social vulnerability.

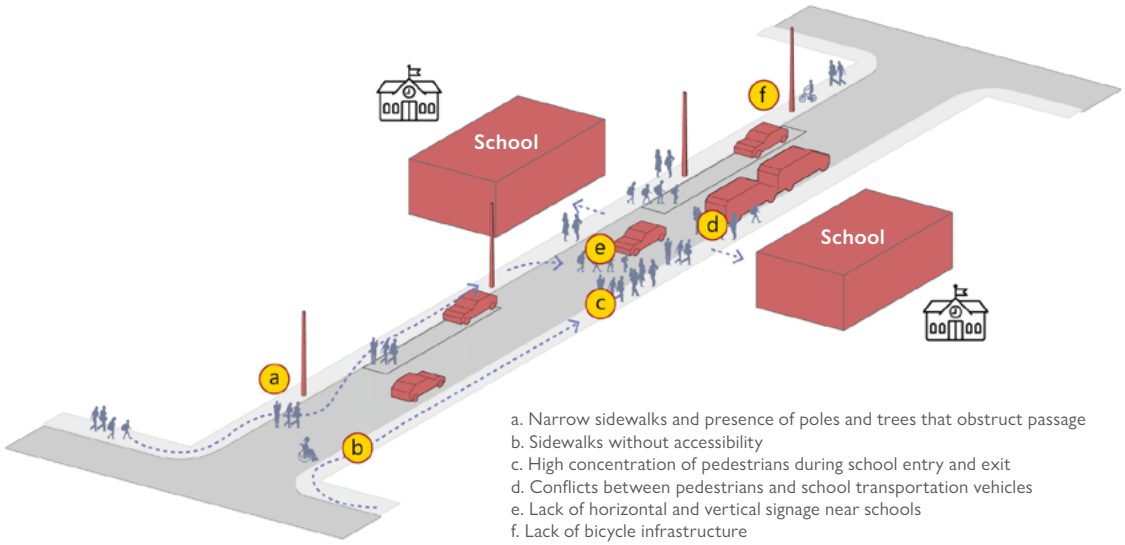
- Cycle 3: inform the groups and individuals involved in the previous cycles of project results, and ask for their support in distributing the final documents and other materials.

The results of the diagnosis and the participatory activities made it possible to assess the effectiveness of the proposed tools and adjust the data survey methodology. The field data highlighted the needs of the target public and the characteristics of the areas surrounding the routes in question. The process of gathering the data also effectively engaged the community and other stakeholders in planning and deploying actions in the places under study, and showcased the role of schools in discussions of urban mobility and in the preparation of appropriate pedagogical materials.

It was clear from the discussions in the various workshops that the PMSP was interested in discussing and assimilating the lessons learned, taking note of the different stakeholders involved (children, parents, caregivers, teachers, neighbors, etc.) in establishing new and safer routes to school and reflecting on the difficulties encountered on the way to school by children with disabilities. The lessons learned in this project make it possible to apply universal accessibility solutions focused on such children. Dialogue on how to best facilitate their access to schools and public transport in the city was incorporated by the PMSP.

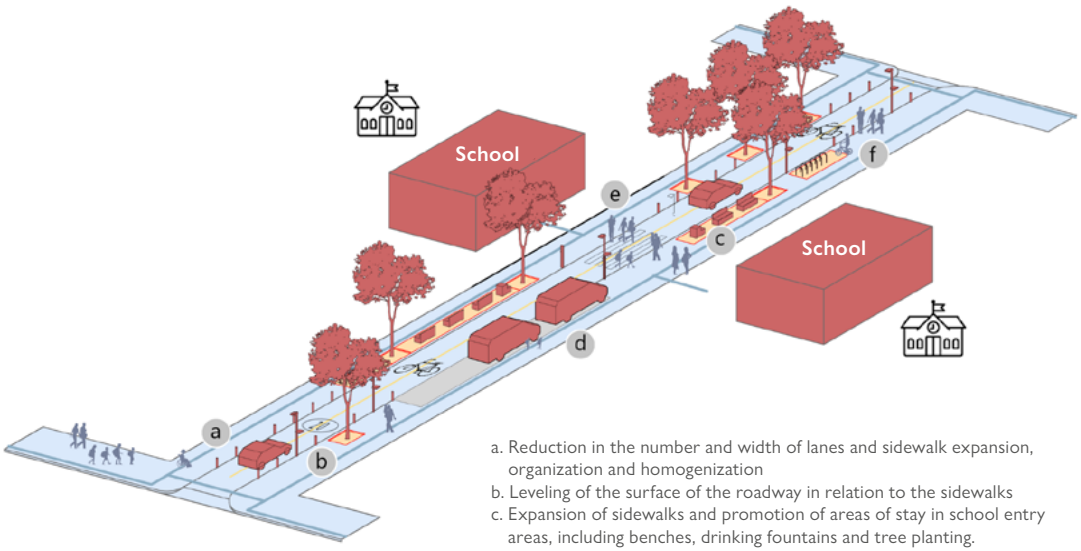
Processing the results led to recommendations for ensuring inclusive access to schools. These were incorporated in an action plan outlining premises, guidelines, and strategies. The action plan specifically addresses key characteristics and behaviors of children and families with functional diversity in the use of public space and school routes. These assumptions are contained in the original CET notes, based on a study carried out in 2017 by the nongovernmental organization Criança Segura, relating to the mobility patterns of children and project actions that must be adopted for the Safe School Routes Program.

The possibilities of implementing the proposed intervention strategies were explored in the surrounding areas of Vila Carmosina and Vila Campestre, analyzed in the previous step. Different types of interventions were developed and recorded in a way that could be deployed elsewhere Figure 30.




a. Narrow sidewalks and presence of poles and trees that obstruct passage
b. Sidewalks without accessibility
c. High concentration of pedestrians during school entry and exit
d. Conflicts between pedestrians and school transportation vehicles
e. Lack of horizontal and vertical signage near schools
f. Lack of bicycle infrastructure

**Current situation**




a. Reduction in the number and width of lanes and sidewalk expansion, organization and homogenization
b. Leveling of the surface of the roadway in relation to the sidewalks
c. Expansion of sidewalks and promotion of areas of stay in school entry areas, including benches, drinking fountains and tree planting.
d. Organization of parking spaces for school vehicles
e. Horizontal and vertical signage near schools
f. Bicycle racks and shared bicycle path.

**Project testing**

**Figure 30 | Proposal developed for the school access road with limited traffic flow (Type A). Source: World Bank (2022).**

Based on an analysis of current practices in the field, the action plan also provides guidelines to support inclusive education in the context of the Safe School Routes Program. These guidelines seek to introduce the themes of urban mobility, accessibility, safety, and inclusion, expanding the approach standard approach to traffic education by using the proposed participatory and inclusive methodology (Box 1).

**GUIDELINES FOR INCLUSIVE EDUCATION ACTIONS**

- Design school routes to be inclusive.
- Take into account the right of all children to the city.
- Consider public space as formative to a child's identity, making it a fundamental part of learning.
- Use a pedagogical methodology[41] that understands education not as a unidirectional process, but as a relational process by which the individual connects to the wider world.
- Raise citizens' awareness of their right to move freely and safely in the public space.
- Create a central hub for the collection, exchange, and preparation of information and materials on the topic of education and mobility.

**Box 1 | Guidelines for educational and inclusive actions. Source: World Bank (2022).**





## RECOMMENDATIONS

The outcomes of the two workshops pointed to the need to open internal dialogue on the actions to promote the inclusion of people with disabilities by the different PMSP bodies. The mainstreaming of universal accessibility in municipal management is one of the biggest challenges for the full inclusion of people with disabilities. The project for accessible school routes for children is promoting a comprehensive dialogue between different municipal bodies on different initiatives and knowledge acquired from these bodies relates to actions that have been carried out to improve universal accessibility for, and inclusion of, people with disabilities. This exchange is invaluable for the MSP since it provides an opportunity to share lessons learned on this particular subject.

The Action Plan aims to complete the CET Safe School Routes Program. The incorporation of the

41 The content that the teacher presents needs to be worked on, reflected upon, and re-elaborated by the student, in order to become his own knowledge. Otherwise, the student does not learn, and may, at best, present a conditioned behavior, based on superficial memory.

assumptions, guidelines, and strategies proposed in the current CET Program promote inclusive urban spaces. Given that most of the proposed strategies are applicable to all urban active mobility interventions, we recommend disseminating the results obtained and incorporating the proposed strategies into new projects under the Safe School Routes Program. This would make it possible to share benefits and opportunities for improving the city's urban mobility by paying attention to human diversity when considering the use of urban public spaces.

### 5.2.9. ACTIVITIES 7.1 AND A.7.2 ANALYSIS OF MOBILITY BARRIERS IN THE CATCHMENT AREA OF THE ARICANDUVA BRT CORRIDOR, AND BASELINE SURVEY OF THE ARICANDUVA BRT PROJECT

#### CONTEXT

During the planning of the Aricanduva BRT Corridor project, efforts were made to understand the reasons for the low mobility of the low-income population living in the corridor's area of influence, including around 29,000 families living in favelas. This analysis specifically considered barriers to the use of public transport, whether physical (restricting access to bus stops), economic (ticket costs), or social (safety perceptions).

This analysis was complemented by a data survey to establish the baseline for the impact analysis of the Aricanduva BRT Project, describing demographics, consumption patterns (connectivity), and mobility in the area and comparing it with a control area in the south of the city. With its database the study serves as a benchmark against which to compare future progress, with the aim of being able to measure the generated benefits such as the reduction of travel time of people going to work or to carry out other activities.

#### WORK STAGES

The study was divided into two phases. The first set out to analyze the barriers and to discover whether other cities had taken steps to mitigate such barriers that could be of interest to São Paulo. The second phrase was to apply the data collected in the survey in the districts of Carrão, Vila Matilde, Aricanduva, Cidade Líder, São Mateus, Parque do Carmo, Parque São Rafael, Jardim José Bonifácio, Cidade Tiradentes, and Iguatemi, located in the east, and in Jardim Ângela, Jardim São Luís, Capão Redondo, Campo Limpo, and Vila Andrade, in the south of the city. The first group of districts is located in the area where the BRT will be implemented, while the second group is in the control area.

The universe of household sample surveys consisted of 4,855 interviews. The largest number of households (51.1 percent of the total) was in the control area (south zone). The target area (east zone) has the

largest number and proportion of people (52.2 percent), due to the higher average number of people per household (2.61 and 2.20 in the target and control areas, respectively).

## RESULTS

A baseline household survey carried out in the framework of the Aricanduva BRT project, collected details about the population living in the area covered by the project, and their levels of mobility. At the same time special emphasis was placed on identifying the barriers faced by families to access essential public services. The survey focused on the following:

### i. Description of the population in the area covered by the project

The majority of residents in the project area were women (53 percent) who identify with the gender assigned them at birth, within the age group of 60 years and over (27 percent). Fifty-three percent of these women identify themselves as white, while 27 percent identified as brown, and 11 percent as black. Meanwhile the age index revealed that for every 100 people under 15 years of age, there were approximately 227 elderly people—a substantially larger proportion than in the MSP overall (57.3 according to the 2010 demographic census). This type of data-profiling analysis could be indicative of the demographic shift in these areas and assist understanding of some of the age-related needs of the target population.

A description of the group of persons living with disabilities was a fundamental part of the analysis on vulnerability and the resulting accessibility proposals. This group represents 5.1 percent of the population impacted by the corridor, with reduced mobility (with or without the use of a wheelchair) being the main problem encountered by members of this group (56 percent) and with the largest proportion of people among the elderly (57 percent). Intellectual, vision, and hearing disabilities represent 17 percent each.

In the group of women vulnerable to abuse or harassment (the majority), only 1.5 percent were identified as pregnant and roughly 2.4 percent were nursing their babies, the majority being between the ages of 25 and 34 years (57 percent) and 8 percent between 15 and 19 years. In terms of color/race, the distribution of this group is similar to the general population, with the majority being white or of mixed race.

Among the people interviewed, the literacy rate (reading and writing) was 91 percent. As for educational levels, around half of the interviewees had not completed high school and 30 percent had not completed elementary education. Sixteen percent of

individuals in the target area were enrolled in higher education. It is noteworthy that more females than males possessed higher levels of education in both the target and control areas, in line with the national trend.

Per capita household income revealed that a significant part of people living in the districts in the target and control areas are in vulnerable situations. Families on the poverty line (earning up to half minimum wage) account for 56 percent of all households. Social vulnerability reinforces the close relationship between territory and income, showing that the neighborhoods that are most remote from the central area host a significant part of the poorest population. Descriptions of these areas as "peripheral" can be applied not only to the territorial distance from the center of the city but can also describe the profile of the majority of the population (treated as truly "peripheral").

### ii. Characterization of population consumption (connectivity/mobility)

Information about internet access is useful for identifying areas with signs of digital exclusion. Around 78 percent of the households in the area had an internet connection, but regardless of the fact that most of the population had between one and two cell phones per person, 24 percent of households shared one cell phone. In a socioeconomic context where homes frequently have no computer, the need for shared use of cell phones implies a major impediment to access spaces and services such as studying, job seeking, and work.

Some 82 percent of families spend up to 20 percent of their monthly costs on public transport. As for those who spend 20 percent to 40 percent on transport, the percentage in the target area is 2 percent higher than the control area. It is clear from this that the poorer families suffer more from transport costs than others, which often acts as a barrier to accessing jobs, education, and leisure.

### iii. Mobility of residents in the project area

In the preceding 12 months, 8 out of 10 respondents traveled more than 2 km to shop and visit relatives and friends. Many people also traveled for leisure (68 percent) and to the bank (39 percent). Half of those surveyed take more than 40 minutes to commute to work or business (an average of more than 50 minutes). The average travel time to the social assistance center is 63 minutes, 33 minutes to health care facilities, 26 minutes to shops, and 21 minutes to educational institutions (usually closer to home).

People with disabilities generally need an average of 8 percent more time to get to work, and 27 percent more time to travel to the Social Assistance Reference Center (CRAS). Brown people spend more time on average commuting between home and work. There are no significant differences by gender. As for the general use of public transport by residents of the target area, 65 percent of those over 14 years of age use public transport on a daily basis, with the bus as the main means of travel (53 percent) followed by own private transport (31 percent). On the other hand, 3 percent of those over 14 years old usually use nonmotorized transport (bicycles, scooters, etc.). The main use of public transport is to travel to work: 66 percent use buses to go to carry out business and 54 percent to workplaces.

As for the availability of transport used to carry out different activities, more than half of the population complained they had no public transport to go the health center or place of study. Many also complained that accessibility to the bus stops is difficult and risky. Around 40 percent of people have no access for one reason or another to public transport to go to the CRAS, to their workplace, or to seek emergency care.

The main reason for choosing the bus and the subway as the main mode of transport is the proximity of either to home (66 percent and 63 percent, respectively). A major reason for using the subway is the better infrastructure (40 percent), followed by safety and speed (28 percent) and the possibility of integration with other modes (23 percent). Meanwhile, the reasons for using the bus are safety (20 percent) and low price (17 percent) for this type of transport. A smaller number of interviewees cited proximity to home as a reason.

Among people in the target group who do not use public transport on a daily basis, the main reasons for not doing so are lack of comfort (44 percent) and short commuting distances (38 percent). The latter generally commute on foot. Other problems include the expectation of long travel and waiting times (29 percent and 22 percent, respectively). While ticket prices and fear/insecurity are not the main reasons for not using public transport, they are nevertheless regarded as barriers by around 13 percent of interviewees in the target area. Poor accessibility was cited by 6 percent.

People in the catchment area generally rate the bus as being much inferior to the subway. Only 26 percent rate the bus positively ("great" or "good") and 20 percent consider it to be "terrible" or "bad." Forty-seven percent of travelers rate the subway or the São Paulo Metropolitan Train Company (Companhia Paulista de Trens Metropolitanos, CPTM) positively, while 8 percent see it as "very bad" or "bad." However, regardless of the negative views of bus travel, people actually use this mode of travel much more than the subway on a daily basis. It is clear from this that implementation of the BRT project assumes even greater importance.

### iv. SWOT diagnosis of the BRT project

The SWOT analysis[42] took account of the main factors identified by the study, separating, as shown in figure 5.14, the usefulness or not of the contribution of the different activities to the project development objectives, and showing whether the scenarios originated within the project or externally.

42 SWOT analysis encompasses scenarios for decision-making, observing four factors: strengths, weaknesses, opportunities, and threats.

| | Useful (to achieve the goal) | Prejudicial (to achieve the goal) |
|---|---|---|
| **Origin Internal (organization attributes)** | •Existing public policy projects in the areas of special fare pricing and inclusion of audiences with access difficulties<br>• Willingness of the local population to use public transport instead of individual transport if access conditions and time are improved<br>• Accessibility of at least 90% of the bus fleet in SP allows better integration between BRT and other modes<br>• Design of the BRT with provision for interventions to improve access to transport and its surroundings, and the project will exceed the coverage area of mobility in public transport and will have public transportation and will have urbanistic implications | • The high degree of inequality in the region of the BRT Aricanduva makes it difficult to define a single approach strategy that achieves the same level of impact among all neighborhoods<br>• Geographic characteristics of the space aggravate the social vulnerability scenario, especially the slope pattern of the territory and the potential for flooding<br>• Low income and high level of informality of the population living in the BRT Aracanduva area reveal structural issues that will not be solved by the measures to include public transportation and that require integration with other areas of public policy |
| **External Source (attributes of the environment)** | • High level of vulnerability of the local population and therefore high impact of the measures proposed by the project with the inclusion of the local population<br>• Improvement of the operational control center with impact for more than 15,000 buses<br>• Identification within the project framework of the current and specific problems of the the corridor's resident population, thus enabling the elaboration of concrete measures | • Constant increase in the value of transport fares as opposed to the increase in informality and the reduction in per capita income<br>• COVID and the population's disincentive to use public transportation<br>• COVID and the increasing number of people working from home<br>• COVID and the increase in informality and unemployment and the reduction in monthly income and access to benefits for formal workers<br>• High economic vulnerability of the corridor population that needs measures beyond the catchment area and the impact that project measures can have |

**Figure 31 | SWOT analysis. Source: World Bank (2022).**

Note: BRT = bus rapid transit.

## RECOMMENDATIONS

A list of 23 proposals was drawn up, based on a global interpretation of the recommendations for increasing inclusion in the Aricanduva Corridor focused on a three-pronged approach: availability of transport for all vulnerable groups; exclusion of all kinds of barriers; and carrying out other types of actions.

This led to the preparation of a list of 15 specific components as a guide for the characterization of 23 proposals, based on the analysis of good practices and experiences presented in the benchmarking exercise, as shown in Figure 32.

| Vulnerable group | Barrier type | Type of measure |
|---|---|---|
| • People with intellectual or physical disability<br>• Elderly, with a focus on those over 60 years old<br>• Women, pregnant women, single mothers, nursing mothers and women responsible for the household without a spouse<br>• Young people, including children and adolescents<br>• Families with low income, precarious housing conditions and unsafe locations<br>• Other people at risk of exclusion, such as black people and people with disabilities LGBTQIA+ collective | • Geography: Distance, Topography, Density, Obstacle, Services available<br>• Transportation: Information, Travel time, Cost of transportation, Infrastructure<br>• Socioeconomic: Income, Occupation, Education, Safety<br>• Physical (individual): Age, Disability, Gender, and Color/Race | • Mechanisms to enhance the perception of safety<br>• Mentoring and training programs<br>• Programs to improve access to school<br>• Inclusive transportation fare programs<br>• Universal accessibility addressed by administrations and operators on three levels |

**Figure 32 | List of actions carried out at the benchmarking stage. Source: World Bank (2022).**

Note: LGBTQI = lesbian, gay, bisexual, transgender, queer, intersex.

The 23 proposals can be divided into eight mechanisms to increase the perception of safety. They also include urban design and transport infrastructure actions and mechanisms for reporting sexual harassment and prevention, two follow-up and training programs, two programs to improve access to schools, six new transport tariffs, and five measures to increase universal accessibility.

The actions listed promise significant improvements for the population as a whole, in the expectation that the BRT corridor will be an example of universally accessible, safe, and inclusive public transport for the whole of society.

The prioritization of short-, medium-, and long-term actions, essential for achieving a successful and effective project was based on the RICE[43] methodology. The RICE index classified the measures into high, medium, and low priority, as in Table 3.



43 This methodology uses the prioritization of measures of a project, evaluating the reach (R-reach), impact (I-impact), reliability (C-confidence), and effort (E-Effort) that each of the measures present in the project can have.

| | | |
|---|---|---|
| High | 1.1 | Working group to combat cases of sexual abuse and harassment on buses |
| | 2.1 | Training programs for independent use of public transport (elderly, children, and people with disabilities) |
| | 5.1 | Implementation of design criteria at BRT stations to ensure universal accessibility |
| | 5.2 | Implementation of design criteria for universal accessibility in the surroundings (areas of influence) of bus stations |
| | 5.3 | Bus fleet with 100 percent accessibility |
| | 1.2 | Information campaigns warning against sexual abuse and harassment on public transport |
| | 1.5 | Harassment/abuse hotline |
| | 1.6 | Apps for reporting sexual harassment/abuse |
| | 4.3 | Student fares |
| | 4.5 | Social tariff for low-income groups |
| Average | 1.7 | Measures at stations to increase the perception of safety |
| | 1.8 | DOT-type measures to increase security in station surroundings |
| | 3.1 | Program to display safe routes for children in the schools of the Aricanduva corridor |
| | 5.4 | ATENDE+ as a BRT feeder |
| | 4.2 | Children's fares |
| | 4.4 | Single-mother fares |
| | 4.1 | Fares for people with disabilities |
| | 4.6 | Fares for unemployed people |
| | 5.5 | Assistance apps to help people with disabilities use public transport |
| | 3.2 | Apps to help children to travel safely |
| Low | 1.3 | Installation of support points at the main BRT stations (personal attention) |
| | 1.4 | Installation of panic buttons |
| | 2.2 | Ad hoc emergency assistance monitoring within the corridor |

**Table 3 | List of actions in order of priority. Source: World Bank (2022).**

Note: BRT = bus rapid transit; DOT = transport oriented development.

Within the group of measures requiring high priority, all vulnerable people will benefit from the proposal, especially women, and other individuals subject to discrimination on grounds of race and LGBTQIA+, youth, and children.

Within the group of measures requiring medium priority, people with disabilities and young people will be especially benefited. This requires measures to be taken to improve the safety of bus stations, and to introduce a set of special lower fares to mitigate economic barriers to bus travel (many already in operation in São Paulo).

Meanwhile, low-priority measures include those with high installment costs and limited impacts (such as help points and panic buttons at the main bus stations). The ad hoc assistance monitoring proposal had the lowest RICE Index score on account of its impact being restricted to individual users.



### 5.2.10. ACTIVITY 7.3: USE OF SPACE AND REAL ESTATE ASSETS FOR IMPLEMENTING SOCIAL INTEREST HOUSING

#### CONTEXT

The expansion of São Paulo's subway lines involves the expropriation of large occupied areas and the consequent removal and resettlement of families. The experience of relocating vulnerable families to other housing units using the Housing and Urban Development Company (Companhia de Desenvolvimento Habitacional e Urbano, CDHU) programs, involves a substantial delay between removal and resettlement. During this interval families live in precarious conditions, receiving official rent aid or some other type of financial assistance.

#### OBJECTIVES

In order to reduce this interval and ensure that the families involved received appropriate housing assistance in the meantime, this study focused on creating a model to make maximum use of the expropriated areas, including the idea of building housing units next to the new subway stations. The objective of this was to produce HIS[44] by involving third parties to develop the airspace (above the bus stations) and any remaining expropriated land, as a way of resettling vulnerable families affected by the subway works. Such developments could also be used in future for other PMSP projects.

44 HIS is a residential unit of up to 70 square meters with up to one bathroom and a parking space for families with a monthly income of up to six minimum wages.

## WORK STAGES

The study covered the following activities:

i. Initial assessment of the physical and urban conditions of the area involved (type of property and surroundings, legal and environmental aspects, etc.).

ii. Assessment of the market potential of the targeted location based on secondary data, considering the specific objective to provide social housing on the chosen sites.

iii. Research on the urban regulations applying to the land, as well as of the tenure status of the property according to available documents.

iv. Economic-financial modeling of a hypothetical housing project, considering future availability for rent or sale, and the structuring, implementation, and operation mechanism (in the case of rent).

v. Survey of the real estate market to map the risks of the development.

vi. Analysis of existing housing programs and policies involving projects similar to the abovementioned model, paying particular attention to issues related to people's access to loans and the structuring of a guarantee system in the event of concession or public-private partnership.

vii. Recommendations on the viability of carrying out social housing projects linked to the subway system, based on information and evidence collected during the study.

## RESULTS

The proposal is based on a simple exchange model, in which the land or airspace made available by the subway company (Metrô) to a private developer would profit from building HIS and other units on the site. The study considered modeling a pilot project at the Aricanduva Metro Station, using the space adjacent to the station that will be expropriated to accommodate the construction site (figure 5.15). A Social Interest Housing Project (Empreendimento Habitacional de Interesse Social, EHIS) was modeled on land which, according to MSP legislation, would benefit from an increase of 50 percent in its utilization coefficient, with at least 80 percent of the computable built area to be used for the housing development. The EHIS also represents an incentive for promoting mixed use of the future development by offering a noncomputable bonus amounting to 20 percent of the area destined for nonresidential uses. EHISs are also exempt from paying the Onerous Grant of the Right to Build

(compensation for additional construction rights), and can reach the maximum utilization coefficient without further payment. Finally, in common with other developments around the mass transit system, the HIS developments would benefit from being able to use 50 percent of the land area for occupation by street-facing shops.


**Figure 33 | Area used for project modeling. Source: World Bank (2022).**

The pilot project under study envisaged Metrô handing over 3,400 m2 of land to a developer using a bond-based sales model in which the property becomes a nonreversible asset with independent and transferrable (saleable) units. The model considered two counterpart options: (1) 58 HIS units for resettlement and an "active facade" (space for shops); or (2) 85 HIS units (25 percent of total units). In both cases the counterpart contribution was equivalent to the value of the land. It is noteworthy that the present study assumes that the land is an asset owned by Metrô free of any encumbrances, with a unique identification number, transcription of possession duly registered, and any expropriations earmarked for social interest purposes.

## RECOMMENDATIONS

Considering the socioeconomic context in the catchment area of the Line 2—Green (Linha 2-Verde) extension, this model enables Metrô to act faster and with greater autonomy regarding the resettlement of vulnerable families, and thus prevents families from being displaced to other parts of the city. The development would deliver to the neediest segments of the population housing that is highly accessible to the metro/railway system, and generate a series of social, economic, and environmental benefits typical of urban densification combined with high-capacity transport. Meanwhile, the commercial exploitation of the other units and the "active façade" to the limit of

the value of the land could add to the nontariff revenues of Metrô, thereby improving the economic-financial situation of the subway system as a whole.

### 5.2.11. ACTIVITY 8: OPINION SURVEY ON MOBILITY IN THE CITY OF SÃO PAULO

#### CONTEXT

During the first few months of the COVID-19 pandemic, the MSP resumed and expanded vehicle rotation in an effort to contain the virus. The measure restricting the circulation of cars one day a week (at peak hours) based on registered number plates, was suspended at the beginning of the quarantine period. In May 2020, the mayor announced that it would resume this mechanism on an even more restrictive basis (i.e., on alternate days, all day, and at weekends), the aim being to keep people at home and contain the spread of the virus. However, popular pressure led to this measure being suspended in less than a week. Traffic returned to the usual pattern only after the quarantine.

The difficulty of implementing restrictive measures on the use of automobiles is not unique to São Paulo. These measures are unpopular by their very nature, as well as generally impractical from a political point of view. During the implementation of 420 km of exclusive bus lanes and 450 km of bicycle lanes, there were several demonstrations against the public administration due to reduced road capacity. Furthermore, it was not surprising that widespread public dissatisfaction with the reduction of the maximum speed on some main avenues of the capital played an important role in the political campaign for the forthcoming election of the city government. The idea of introducing a congestion charge for São Paulo was examined, but no mayor was able to implement it.

Communication is a fundamental element for implementing any public urban mobility policy, especially the most unpopular ones which prioritize investment in active and collective transport and discourage the use of cars. People generally need to know the reasons for, and relevance of, any mobility initiatives that might affect them, and it is important that any measures designed to increase the public's knowledge and adherence to new policies need to be communicated in a robust and positive way.

#### OBJECTIVES

The opinion poll, planned to throw light on users' social concerns, was basically a qualitative and quantitative public opinion survey designed to improve communication with the population, and thus ensure better implementation of projects developed within the scope of the Program. The main objective was to understand the population's viewpoints on the Program's themes and generate in-

formation for the PMSP to prepare a communication plan for implementing the proposed measures.

The survey aimed to gather information on the characteristics of current urban mobility in São Paulo, and key challenges during the pandemic, and seek to identify the main stakeholders in the mobility area, in addition to obtaining the views of São Paulo's population on the policies and interventions related to urban mobility.

## WORK STAGES

The study was developed in four stages:

i. Online diagnosis with digital mobilizers panel;

ii. Qualitative research;

iii. Quantitative research; and

iv. Communication planning.

In the first stage of the work, an online public opinion survey on mobility issues was carried out (bike lanes, pedestrians, toll collection, parking fees, public transport subsidies, bus lane modernization, etc.). A panel of influencers, experts, detractors, and narrators on sustainable mobility and the use of urban space was also established. The qualitative survey involved five focus groups. This led to the preparation of a quantitative research questionnaire encapsulating a statistical survey of public opinion on mobility and topics listed in the two previous stages.

## RESULTS

### i. Online survey: Population's views on mobility

The online survey in October and November 2020 addressed 11 topics: cyclists, traffic, pedestrians, buses, delivery couriers, apps, cars, the subway system (Metrô), CPTM, and mobility. The digital thermometer made it possible to gauge people's views about urban mobility in São Paulo, and to identify prevailing narratives in each of the thematic groups. Diagrams were used to highlight the dynamics of the online conversation on

Twitter, and enabled the creation of vector panels/graphs, as illustrated in Figure 34. The main contributors to the mobility topic on social networks were identified (newspapers, digital influencers, activists, experts, ordinary citizens, etc.).

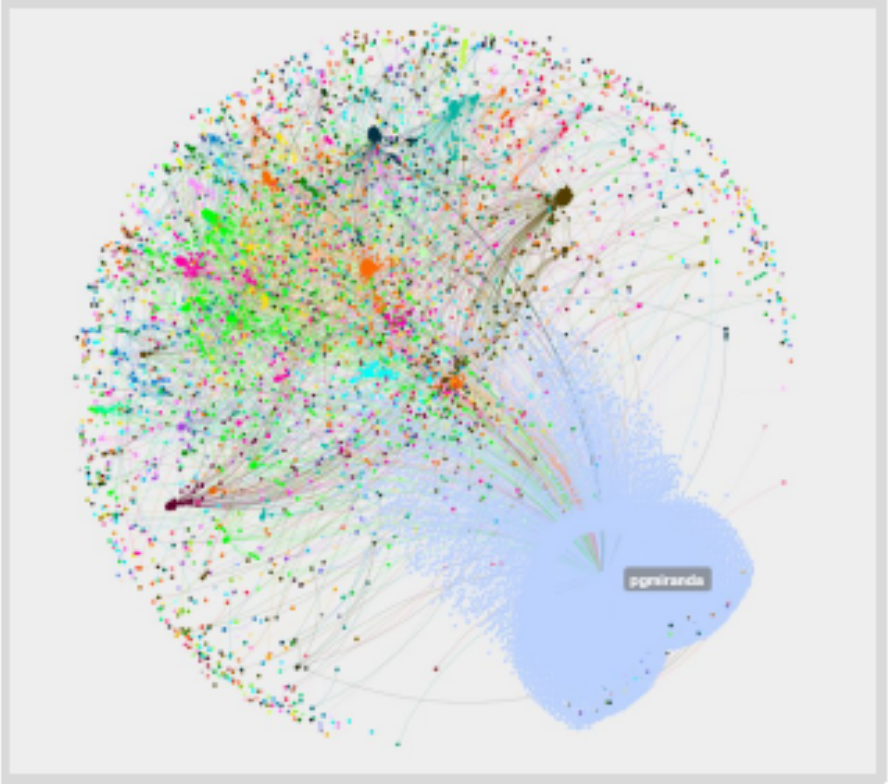


**Figure 34 | Digital Thermometer. Source: World Bank (2022).**

The public transport topic was mentioned 3,825 times during the monitored period, 63 percent of the time by politicians and 23 percent by the press. Approximately 51 percent of comments were by women. The main term mentioned was the "free pass" (passe livre), which related to the ongoing debate about the proposal for free bus passes for students in São Paulo. The discussions by the municipal management focused on bus fare increases. The reduction of assistance to student users was also mapped (the controversy about student passes was said to cause increased school dropout rates). Other comments mentioned bus waiting times due to delays, and the quality of the services in general.

The cycling theme was mentioned 31,359 times, with 72 percent of these by the press. The narratives thermometer drew attention to demands for investments in cycle paths to be decentralized and directed toward the peripheral neighborhoods of the city. There were several mentions of violence against cyclists by other road users, and the need for

public policies designed to raise awareness of the use of bike lanes. Mobility apps were mentioned 3,855 times—58 percent by public institutions and 23 percent by the press. Users generally defended noninterference by the state in transport apps. For example, one of the most widely commented cases was the attempt by PMSP candidates to intervene in apps such as Uber. Defenders of this ride-hailing service argued that Uber was a private initiative that had improved transportation in São Paulo, and called into question the alternative state-run transport arrangements. Criticism also extended to the difficulties imposed on the use of micromobility and on-demand bus apps.

### ii. Qualitative research

Qualitative research involved five focus groups, each consisting of five people with different socioeconomic profiles. In the first group, formed by cyclists and delivery men, it was generally perceived that before cycle lanes were installed many cyclists were victims of traffic accidents. The group argued that despite progress made on establishing bike lanes and paths there was still much more to be done in São Paulo to improve the cycling environment. The lack of traffic education was highlighted by the group as one of the main drawbacks in terms of cyclists' urban mobility.

The second group was formed exclusively of pedestrians, predominantly concerned about the poor quality of sidewalks, potholes, and urban violence involving thefts, muggings, and so on. People in this group nevertheless had positive views on closing roads at weekends and reducing road speeds. The third group was made up of app drivers, taxi drivers, and private car owners using their vehicles to get to work. There is a perception in this group that time spent in traffic holdups could be employed more usefully in other aspects of life. At the same time they complained that ridesharing apps had attracted more cars to the roads and created more congestion. Drivers in this group did not feel responsible for traffic accidents, shifting the blame to third parties such as motorcyclists, pedestrians, cyclists, and the public authorities, and were very concerned about theft and violence in the traffic. Negative views were also expressed in this group about the "fines industry," the scarcity of places to park, and the high fees charged in rotary parking lots (Blue Zone).

The fourth group contained bus, metro, and CPTM users, including a number of residents of São Paulo and its Metropolitan Region. Respondents agreed that rail transport was of good quality, delivering a fast and reliable service. However, most complained about other transport options: overcrowded buses, subways, and trains at rush hour, and the high ticket prices that were incompatible with the quality of the services.

The fifth and final group was formed of women users of public transport (subway,

CPTM, and/or bus). Violence against women was the main issue mapped. Verbal and visual harassment tends to be part of the daily life of women users, especially at peak travel times. The possible solutions suggested by the survey respondents were: creating women-only wagons on the subway and trains, increasing the number of buses to reduce overcrowding; training professional staff to address these issues; fixing notices to instruct women what to do in the event of harassment; and, finally, installing surveillance cameras inside vehicles and at stopping places.

### iii. Quantitative research

The quantitative survey was conducted by telephone with 1,000 respondents in April 2021, using stratified sampling of the MSP population as the statistical technique. The maximum estimated margin of error of the results from the sample was plus or minus 4.5 percentage points.

Respondents to the survey justified their travel mode choices by highlighting factors such as satisfaction with the comfort and speed of the service provided, whereas the reasons for choosing to travel by bus related more to the capillarity of the system. The survey results indicated that the main motivation of those who use buses was ease of access (55 percent) and the low cost (29 percent), while the subway and trains were chosen for their speed (49 percent). Individual car users highlighted convenience (38 percent) and comfort (25 percent). The outcome was similar for app vehicles and taxis, generally chosen for their convenience (25 percent), comfort (23 percent), speed (18 percent), and safety (14 percent). Speed (53 percent) and comfort (26 percent) were uppermost in the opinions of motorcyclists. The low cost of cycling was the main reason (75 percent) for using this mode of transport. Finally, support for travel on foot was favored due to three advantages: easy access (40 percent), low cost (24 percent), and speed (16 percent).

When stratified by income, it is clear that variables such as ease of access, speed, and low cost are the main justifications for choosing a particular transport mode for people earning up to six minimum wages—about 65 percent of respondents. The higher-income groups chose convenience and comfort (61 percent). Earners of up to six minimum salaries claimed that among the transport modes they would like to use more, the subway was the main choice, while the car was the top option for higher earners. The justification for choosing one means of transport or another tends to differ: people prefer the subway due to its speed of travel (90 percent), while those who like to use the car and transport apps are more interested in comfort (86 percent). Only 14 percent of respondents said that they would like to travel more on foot and by bicycle, with fitness reported as the main reason (75 percent and 70 percent, respectively) for this choice.

According to the survey respondents, the main mobility challenges in São Paulo were traffic congestion, overcrowding, delays caused by late buses, long travel times, and high ticket prices. Around 41 percent of respondents answered that motorcyclists were predominantly responsible for mobility problems in the city, while 25 percent ascribed this to private cars. On the other hand, this group considered cyclists to be only marginally responsible for the problems, demonstrating the structural change in the perception of cycling in the city. Other data confirming this change were the measures for prioritizing more democratic use of the streets: the introduction of more bus lanes (21 percent), the expansion of sidewalks and pedestrian crossings (19 percent), and more bike paths (13 percent). Regardless of the initial resistance to implementation of these measures, they appear to be gaining popularity.

About 95 percent agreed with the statement "The waiting time and overcrowding of buses impact the users' day to day routines." A further statement, keenly supported by 81 percent of interviewees, was that "There is a lack of investments in viaducts and tunnels to improve congestion," whereas only 40 percent of respondents opined that app vehicles had led to worse congestion. On the other hand, approximately half of the respondents agreed that "Parking needs to be created for businesses" (51 percent agreement) and that "Parking meters only serve to fill the PMSP coffers" (49 percent agreement). Among car users, 38 percent agreed that "Streets are a priority for cars, since drivers pay Vehicle Tax (IPVA)." The survey further suggests that pedestrians were not acknowledged as a group, but nevertheless this segment agreed that it was better to extend parking places rather than install more sidewalks and bike lanes.

Finally, radio (68 percent) and television (64 percent) were considered to be the most reliable sources for mobility-related news, whereas exchanges of views on mobility between friends, relatives, and colleagues occupied third place (58 percent), ahead of the internet, social media, and newspapers. The internet (49 percent) and social media (34 percent) were considered relatively reliable sources for news, second to television (57 percent). Television was considered the best information channel for governments to inform the population about mobility improvements in São Paulo (71 percent).

## RECOMMENDATIONS

Based on the data collected in the surveys, it was possible to put together an effective communication plan, focusing on the population groups affected by each public policy. For this plan to become a reality, it is necessary to conduct continuous mapping of the population and to increase open channels to engage with citizens and continue listening to their needs (e.g., Câmaras Temáticas).

# CHAPTER

# 6 | IMPACTS

The expected medium- and long-term outcomes of the implementation of the Smart Mobility Program include improving the efficiency and equity of the urban mobility system and promoting a better quality of life for citizens, especially the most vulnerable. In summary, the Program:

- **Promotes the inclusive and sustainable development of the city;**
- **Provides quality urban transport services;**
- **Boosts the efficiency of the mobility system and new service delivery models.**

The results of the Program and its related studies show that for mobility to be more efficient, inclusive, and sustainable, the multiple challenges faced by urban transport must be dealt with simultaneously and synergistically, since the solutions to São Paulo's urban mobility problems are not only technical or financial, but involve a series of other key factors.

The studies consider best practices at the international level, as well as the specific social, economic, and infrastructure conditions at the local level. Since this approach was robustly supported by different São Paulo City Hall (Prefeitura Municipal de São Paulo, PMSP) sectors, it was possible to start by first examining the problems normally addressed by specialists on a daily basis and take advantage of their expertise. It was also possible to develop teamwork and to highlight new solutions and ways forward, and to pinpoint targets and identify the critical elements of the mobility system that effect users' daily lives.

The Smart Mobility Program incorporates a number of initiatives that exceed its original concept. These were based on suggestions from the World Bank and Municipality of São Paulo (Município de São Paulo, MSP) teams or from contracted consultants. Continuous dialogue between the teams made it possible to adjust the scope of activities, thereby enhancing the innovative nature and viability of the Program.

The Smart Mobility Program achieved more than 96 percent of its previously defined targets and provided important insights into the public transport sector in São Paulo. Technical assistance also contributed. Key recommendations and methodologies for similar environments going forward benefited greatly from the technical assistance input. In addition to the direct contributions made by the study teams working under the Program, cooperation among other teams generated new expertise in the field of mobility, as was acknowledged during the closing event. The many contributions had one goal: to support the process of transforming the MSP as a global benchmark in urban transport systems.

The main impacts of the Smart Mobility Program are detailed below, organized by the relevant team.

## 6.1 | THE CITY DESIGNED FOR THE CITIZEN: A CLOSER LOOK AT GENDER, RACE, AND ACCESSIBILITY OF THE MOST VULNERABLE POPULATION GROUPS

The World Bank and PMSP teams worked hard to see infrastructure from a human perspective, by considering the creation of bus corridors specifically tailored to facilitate public access to bus stations and terminals. The teams also collaborated with the Traffic Engineering Company (Companhia de Engenharia de Tráfego, CET) to promote access to the Municipality Safe School Routes Program (CET 2019), among others[45].

Based on the work to incorporate the Microaccessibility Manual solutions into the Urban Design Manual, the PMSP agreed to focus on planning universally accessible safe school routes in the city. This involved a grant from the Education for Inclusion Initiative to complement the CET Program with a joint proposal between the World Bank and PMSP. The aim and timescale of the proposal were aligned with an important ongoing activity (A6.3) targeted at people with special needs. The resulting activity (A6.5) will provide key recommendations for improving accessibility for children with disabilities in future CET bidding exercises for two Safe School Route executive projects. Two

45 Available at: < http://www.cetsp.com.br/media/1017533/bt-63-07-02-20-.pdf >

further tenders are to be launched in the coming months and are expected to include recommendations for safe and accessible school routes for all. It will also impact future projects in the City of São Paulo such as the Aricanduva BRT corridor and other infrastructure projects with the inclusion of accessibility improvements.

## 6.2 | EVOLUTION OF THE MOBILITY TECHNOLOGY ECOSYSTEM

The question of technological infrastructure focused on the integration of São Paulo Transportes S/A (SPTrans) computer systems and on the traffic light network. These two issues, together with the governance analysis for Mobility as a Service (Mobilidade como Serviço, MaaS) and the reorganization of the bus lane databases, aimed to bring about a noticeable improvement in bus service quality and efficiency.

The traffic light network's size and structure make it a core component of the efficient management of urban traffic and associated externalities, and a key part of communication infrastructure to underpin mobility services at the municipal level. The traffic light system is the basis for extensive deployment of smart transport systems that can improve the efficiency of traffic operations involving different modalities, as well as cut journey times and improve safety for all users of the transport system.

This kind of network would evolve as a source of data and information to capture mobility needs and serve as a basis for decision-making. It would also provide the PMSP with an additional tool to quickly connect to users of the systems and accelerate the pace of development and evolution of a public MaaS platform, bringing together different transport systems, enabling more straightforward use (and simpler organization) of the existing network, and attracting users to public transport and active modes. Control by the PMSP of different systems and means of travel (as are starting to appear in several countries) would provide a powerful tool for promoting sustainable travel behaviors, which would in turn benefit the mobility system as a whole. This concerted approach naturally needs to be sustained from a logical and technological viewpoint, as well as from the institutional and legal angle (see subsection 7.6).

The creation of a mobility framework based upon a logical functional substrate consisting of organized stakeholders in the mobility area at the municipal level, and the creation of future systems to be hosted and integrated in the new COP (SPTrans control center), made it possible to prepare a roadmap for the future use of cutting-edge technologies such as artificial intelligence and big data, and the integration and improved coordination, physical or otherwise, with other essential services involved in operating the transport system (CET, metro, São Paulo metropolitan train company [CPTM], police, fire department, mobile emergency medical services [SAMU], etc.). This dialogue

was brought into the internal discussions in PMSP thanks in part to the recommendations made under Pillar 1 activities. The systems designed in the context of the Program are either being tendered or specified by SPTrans at the moment, with the aim of achieving the integration of its technological environment by the end of 2023 in order to make it fully functional for a MaaS platform currently being evaluated by the PMSP.

## 6.3 | BUS CORRIDORS – DEVELOPMENT, MANAGEMENT, AND FINANCING

The audit of corridor safety and universal accessibility, carried out within the scope of Activity 5.2, inspired the PMSP to carry out a second analysis of the bus terminals (Activity 5.3) in view of the bids for the concession of a number of terminals in the city. The study identified an opportunity to apply a methodology similar to Activity 5.2 to create a baseline analysis and use it as a quality indicator for this purpose. The methodology was adapted and used in two bus terminals (Cachoeirinha and Tiradentes) in the expectation that the PMSP would also apply it to other terminals. The study also emphasized the need to promote greater user accessibility by taking a broad approach to corridors, considering their urban surroundings rather than focusing simply on the avenues on which the corridors are being implemented.

Methodologies were also defined to improve the operation and maintenance of the corridor infrastructure, by establishing proactive maintenance contracts for the road pavement. The corridors analysis, initially developed for highways, was basically adapted to suit the urban environment. Finally, an analysis of the additional revenues from construction of social housing in the remaining areas of the corridors was incorporated. Both activities were well received by SPTrans (the main stakeholder of Activity 4), and discussions are progressing on the next steps, potentially to benefit the construction and maintenance of new bus corridors in the city.

## 6.4 | DEMOCRATIZATION OF ROAD SPACE AND PROMOTION OF SUSTAINABLE MOBILITY

The use of road space in a more balanced way, prompting more efficient and sustainable modes and compatibility with existing corridors, increases the attractiveness of public and active transport, and can lead to the migration of current users of individual motorized means to public transport. The analyses carried out within the scope of the Program provided key inputs for improving planning with a view to better reflecting the types of users of the municipal mobility system, and encourage a more equitable division of urban space for the circulation of people and goods.

This framework provides the necessary support for the deployment of effective policies to promote social inclusion and environmental sustainability, as well as boost the economic competitiveness of the city's productive system by creating jobs and the different neighborhoods where these types of recommendations are implemented.

## 6.5 | SMART TRAFFIC LIGHTS TO PRIORITIZE PUBLIC TRANSPORT AND ACTIVE MODES, AND NEW FORMS OF MANAGEMENT

The studies identified that the MSP needs a new traffic light management model that allows buses in the future corridors to have priority over other vehicles, and to serve as a model to ensure that road and street intersections can contribute to more efficient mobility for users of public transport and active modes of travel. This would be a major development in congestion reduction compared with the current system that favors only motorized transport. For this to happen, it is vital to think in terms of new management models for improving maintenance and also to have centralized control mechanisms capable of switching traffic priority flows as necessary. This recommendation was described in the action plan for Activity 2.2.

## 6.6 | GOVERNANCE—POLICIES AND REGULATIONS

Facing the many challenges of urban mobility in the city of São Paulo requires the interaction and cooperation of a large number of stakeholders (institutional and others) with different skills, responsibilities, and interests. In order to provide technical support to the PMSP in this task, the objectives of each stakeholder were scoped in the course of the Program, and as a result of the international benchmarking analyses, the proposal for an integrated conceptual model of governance gradually emerged.

Finally, progress is needed to identify the components of the MaaS, including determining the specific functions of a potential business unit to form part of the broad and integrated process of moving passengers around the city, from origin to destination, thereby providing an excellent, good-quality, and sustainable travel experience, as proposed in the recommendations of Pillar 1 activities.


CHAPTER
7

# 7 | LESSONS LEARNED

From Program inception to its conclusion a number of important lessons were learned, not only with respect to continuing the São Paulo Smart Cities Program, but also for conducting new studies of this type. Four themes are worth highlighting related to (1) technical scope; (2) duration of activities; (3) self-organization to carry out activities; and finally (4) communication and dissemination methods.

Each of these themes involves two approaches: (a) the development of the project itself and (b) the implementation of the Program as a whole, as shown in Table 4.

| Scale | Project | Program |
|---|---|---|
| Coverage | Scope | Conceptual model |
| Duration | Preparation | Implementation |
| Organizational structure | Teams | Stakeholders |
| Communication | Internal | Public |

**Table 4 | Approaches and relevance of lessons learned. Source: World Bank (2022).**

## 7.1 | TECHNICAL SCOPE

**Scope of work:** Development of the work, particularly at the beginning, revealed opportunities for studies on the most varied mobility topics, and selecting and scoping the topics proved to be a difficult task due to the vast number of materials available. Furthermore, in the course of developing the work, the specific needs of the São Paulo City Hall (Prefeitura Municipal de São Paulo, PMSP) (the end beneficiary of the project), needed adjustment, which altered the scope of the contracted services. It is important therefore to hire consultants with some contractual flexibility, or to prepare contracts containing specific clauses to enable validation of details, at some point, to ensure that contractors are able to meet the specific needs of the end beneficiary of the studies.

**Conceptual model:** Given the diversity of topics considered in the Smart Mobility Program, it was necessary to identify a conceptual model for coordinating all the activities in order to guarantee consistency and synergies from the preparation and design stage onward. Apart from indicating the contribution of each activity to the intended Smart City, it was possible to highlight gaps that could not be addressed in the course of this Program, and which call for further study in the next actions.

## 7.2 | DURATION

**Studies:** Although not under the control of the World Bank teams, the reduction of the time for conducting the studies made it difficult to analyze themes in more detail, as well as making it impossible to implement pilot projects to test the accuracy of the proposed actions. One of the lessons learned when carrying out projects of this type is to develop levels of detailing in hierarchical order to ensure the consistency of a complete plan, at whatever depth necessary. In the event of interruptions due to force majeure, a structured and complete plan will therefore always be available to support the continuation and implementation of the project concerned.

**Program:** Given the size and diversity of this Smart City plan, it is essential to discuss the implementation schedule with the end-customer's teams, and make plans for a system for monitoring and updating. In view of the technological innovations available in 2022 and the items covered in this plan, it is essential to prepare this implementation schedule to ensure that the various proposals do not risk early obsolescence, and to seek flexible solutions that are compatible with the dynamics of technological development.

## 7.3 | ORGANIZATIONAL STRUCTURE

**Development teams**: The following groups of professionals worked on the development of the plan: (1) British Government, through the UK Prosperity Program teams; (2) World Bank, as manager/executor of the Program; (3) specialist consultants contracted by the World Bank to prepare the technical analysis; and (4) PMSP as the final beneficiary. Leadership in each of these groups was of fundamental importance for the synergistic continuity of the implementation of the work. Changes in leadership caused some difficulties for the continuity of the Program (e.g., changes in focal points). Although these setbacks were quickly resolved, it is important to pay special attention to this particular issue to ensure that future studies can be conducted more cohesively.

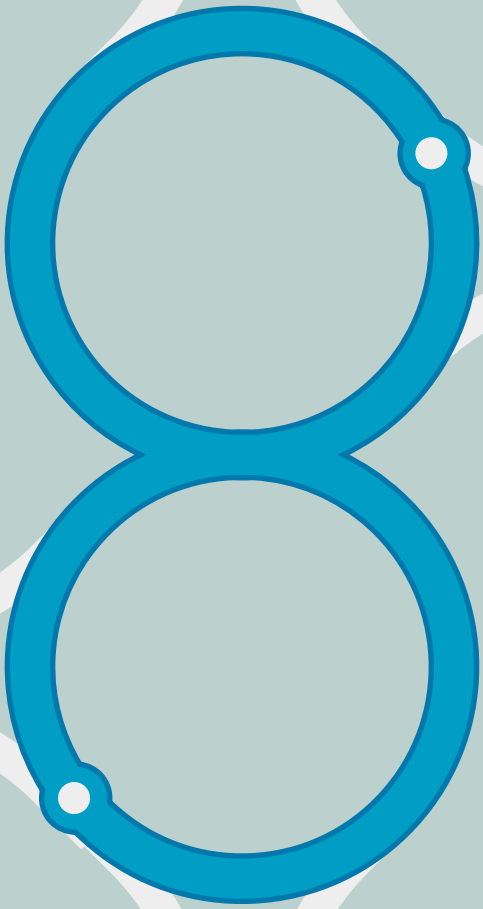
**Practitioners involved in the implementation of the Program**: Considering the scope and diversity of the Program, successful implementation requires an organizational structure which defines clear and very specific responsibilities and time frameworks. While these attributions were redefined throughout the execution of the studies it would have been more advantageous to have done this at the beginning.

## 7.4 | COMMUNICATION

**Internal:** Given the significant number of professionals involved in the work (almost 20 activities carried out by consultancies with several collaborators in each, interacting with technical teams from the PMSP, World Bank, and UK Prosperity Program), the creation of an interactive digital platform to support coordinated development of the work is essential. In this study, such interaction took place through file sharing between defined groups of people, in addition to periodic workshops held at the workplace aimed at keeping the teams informed. It is recommended to evaluate and use the increasingly sophisticated technological tools for future works.

**Public:** A communication system for informing the community/population is essential for effective deployment of the actions recommended in the Smart Mobility Program, not only for identifying people's needs, but also for disseminating information of the various actions to enable people to benefit fully from them. Several studies have included surveys and participatory dynamics. Workshops and focus group discussions have, for example, produced valuable contributions from the public and should be widely adopted in all the program activities implemented.

# CHAPTER



# 8 | GENERAL RECOMMENDATIONS FOR DEPLOYING THE SMART MOBILITY PROGRAM

The successful implementation of the Smart Mobility Program requires two lines of action: (1) activities needed to carry out the Program as a whole; (2) specific actions for developing and implementing the activities. The strategy recommended for the first group aimed to ensure deployment effectiveness and expected benefits of each project through the actions of the second group. These recommendations for Program implementation seek to achieve the Development Goals, and are not related to each individual activity.

Considering the recommendations of each activity, the following types of measures are needed:

i. Contracting studies and training programs;

ii. Development of management and communication systems;

iii. Economic-financial and business model modeling;

iv. Budget forecast;

v. Launching of bid notices for investments in infrastructure and systems; and

vi. Structuring and financing of the Program as a whole, as detailed in chapter 9.

The general reommendations involve management measures and organizational structuring, as well as seeking funding sources for implementing the Program. The recommendations described here derive from the recommendations of each activity and are classified and listed in groups of measures to be taken in general, as described below..

## 8.1 | GENERAL RECOMMENDATIONS FOR DEPLOYING THE SMART MOBILITY PROGRAM

Several of the technical recommendations described in chapter 6 stress the need for deeper studies, and for preparing practitioners who are to be involved in the Smart Mobility Program. There is a need therefore to hire consulting services to train the teams involved and work on the details of actions of the plan, including the following:

- Strategy for traffic light modernization: Given that traffic light maintenance and modernization was recently incorporated into the city lighting public-private partnership (PPP), it is necessary to map the scope of this contractual amendment and identify the stakeholders involved in order to present, validate, and/or adjust the modernization proposals conceived in this study and identify synergies and complementarities. The objective of this would be to learn what is contained in the PPP amendment, or what needs to be additionally contracted, considering the necessary prioritization of active modes and public transport in terms of the traffic light network.

- Speed up progress on integrated transport, involving the approach taken in the recommendations for (1) new corridors; (2) the Mobility as a Service (MaaS) policy; and (3) shared space. It is necessary to consider the set of recommendations for each activity that promotes a robust interdependence in terms of integrated transport. In this respect, it is recommended to mobilize a task force within the São Paulo City Hall (PMSP) in order to better understand this context and interact with the Metropolitan Transport Secretariat (Secretaria de Transportes Metropolitanos, STM) and its current development of the Integrated Urban Transport Plan (Plano Integrado de Transportes Urbanos, PITU). On the other hand, when studying corridors, thought should be given to the trunking of services, possibly highlighting the role of MaaS in this respect. Finally, a more detailed study of road space sharing among the different mobility modes in the context of integrated mobility will enable the identification of necessary and appropriate investments to adjust road space availability in a balanced way.

- Progress the new MaaS-aligned ticketing model: Further analysis and more thorough studies on ticketing mechanisms are suggested as a way of identifying components of the model such as tariff policies, formulating agreements with partners, business models, means of payment, ancillary revenues, financial management, clearing, and so on. Given that the topic would need to be considered in the next stages of the Program, it is recommended to hire a consultancy to understand the state of the art and the structure of the current ticketing model, identify practitioners and agreements, and prepare regulatory proposals for the partnerships required to take forward integrated and smart mobility. The products of this work may point to new opportunities and highlight indicators needing consideration in the PMSP's mobility and accessibility georeferenced information system—SIGMA.

- Integration of mobility and social interest housing (Habitação de Interesse Social, HIS): The question of providing housing for low-income people (HIS) was inserted in this study in order to demonstrate the benefits of building in the airspace in and around transport stations. In order to ensure good results for the city as a whole (people, managers, and operators) the recommendation is to increase the scope of the studies already carried out to include the mapping of locations in the city's territory, and their potential for providing accommodation to families in built units, as well as to explore mechanisms for capturing added value in favor of smart mobility. In this context it is also important to liaise with the teams developing the PITU 2040 Plan, since that particular plan contains a proposal for Transport Oriented Development (Desenvolvimento Orientado ao Transporte, DOT) policies based on the densification of land close to transport hubs and systems. The combination of these two studies will contribute to highlighting the practical opportunities for implementing proposals for urban reorganization.

- Training program on inclusion in transport: Considering the recommendations, especially those in Pillar 2, which advocate sustainable and inclusive mobility, a permanent training program to disseminate inclusive policies and project concepts for eliminating barriers is recommended. It is expected that such a training program will ensure that all the studies and projects related to the transport systems being developed would take into account all the recommended measures, and would be operated in a way to guarantee the potential benefits of such measures. It is therefore necessary to formulate a structured program containing indicators showing the results of their practical application to be incorporated in the SIGMA.

- Planning and operationalization of the new urban logistics: Establishing a committee of stakeholders to discuss regulatory issues related to urban logistics requires mobilizing an initiative by a public or private body exercising a leadership role. It is recommended that the PMSP assume this initiative, inviting the private sector to a permanent discussion and assessment of the risks and opportunities for the development of

supply chain solutions in the Municipality of São Paulo (Município de São Paulo, MSP), followed by actually initiating actions to improve the optimization of urban logistics of the city. It is worth noting at this point that the PMSP's pioneering initiative to carry out the Freight Origin and Destination survey, which continues to develop and provide important additional information to the Smart Mobility Program.

## 8.2 | DEVELOPMENT OF MANAGEMENT AND COMMUNICATION SYSTEMS

Some of the Program's activities focused on proposing and detailing the management and communication systems. The recommendation for the next step is to prepare specifications to bid for consultants to develop and implement these systems. As with the recommendation to carry out complementary studies, systems development belongs to the group of recommendations covering various activities on integrated management and information systems. Three main actions are therefore highlighted: (1) development and implementation of the SIGMA; (2) development and implementation of the Operational Management and Monitoring Systems (Sistemas Monitoramento e Gestão Operacional, SMGO) and Data Lake; and (3) the establishment of a permanent process for conducting surveys on the perception of mobility systems.

- **SIGMA:** The system was conceived in the Program through the identification of a set of functionalities and algorithms for calculating indicators principally related to the supply of transport services and the implementation of the MaaS model. It became obvious, however, as the other activities of the Program progressed, that it would be necessary to formulate additional indicators related to, for example, gender, race, mobility restrictions, social barriers, safety in the corridors system—a set of indicators requiring monitoring and that go beyond the characterization of transport supply. It is therefore recommended that in the specifications for developing the SIGMA, the other studies initiated by the Program should be taken into consideration and the recommended indicators extracted from them in order to provide additional modules in the SIGMA system.

- **SMGO and Data Lake:** The SMGO system was already included in SPTrans plans since the renewal of the concession contracts. The system is an integrated one designed to coordinate, complement, and replace a series of different applications supporting the management of the city's bus service operations. In the Smart Mobility Program, the SMGO was examined from the angle of its suggested functionalities based on specifications that had already been prepared in the concession bidding notices. In the course of the work, however, the need for data flows between systems

became evident, and it was therefore suggested to implement Data Lake for integrating data. The SMGO will consume and produce data for Data Lake. This data module can be contracted either together with the SMGO, or with the SIGMA. However, given that the SMGO contains very detailed data on the operation (scheduled and completed), it generates remuneration as well as ticketing data. Given that this mechanism possesses a disaggregated database of substantial size, it is suggested that the analysis and implementation of Data Lake must be done in tandem with the SMGO (in the same or another contract, separately or in the SIGMA contract).

- **Perception survey:** In the course of the Program's activities, field research and surveys were carried out with focus group discussions to identify a set of references to support the transport system proposals. It is recommended that, in addition to considering and structuring all the surveys carried out, a permanent process of mobility perception surveys and social impact evaluation of new projects should be established. This could be operationalized using a specific SIGMA module, with a platform for data collection and interfaces for consulting results, and containing all the elements related to inclusion, barriers, quality, safety, and so on. Thus, they would form a single one-stop model highlighting the importance of surveys and citizen participation in the management of the mobility system.





## 8.3 | ECONOMIC-FINANCIAL MODELING AND BUSINESS MODELS

The implementation of the actions proposed by the Program requires a substantial amount of investment. The first step is to formulate a rough estimate of the costs and business models that are suited to the implementation of the actions.

One of the solutions to ensure that Program deployment matches the proposed time frames is to persuade the private sector to invest in infrastructure and exploit commercial services in return for payment in the form of operating fees, possibly as counterpart payments awarded by the concession-granting authority or even being awarded by public service concessions. Consideration could also be given to provide performance bonuses for private operators to reflect their results, providing of course that such benefits are quality controlled by the government.

Based on the studies carried out under the Program, some business modeling can be initiated already, and thus help to consolidate the baselines for the priority deployment of the Program. The following recommendations apply to immediate modeling:

- **Modeling for the proactive maintenance of corridors:** Maintenance services to be considered as an addendum to bus system concession contracts, or to be included as an integral part of the contract at this time of renewal.

- **Modeling the MaaS plataform for Phases 4, 5, and 6 involving:** (1) consideration of on demand bus services, and HIS and DOT developments in general; (2) charging fees for the use of public infrastructure by private transport systems; and (3) the engagement of different private operators and their integration with the public services (taking account of the need to adjust and regulate the systems to support the developments proposed under MaaS). It is worthwhile noting here that the Phases 1, 2, and 3 MaaS concepts are already developed enough to be contracted in the short term, as recommended in the launch of public tender notices discussed below.

- **Models to use 5G** within the scope of the traffic light modernization program which proposes to employ this technology, thereby also creating the potential for supplying ancillary services in addition to using 5G for the smart traffic light systems.

Certain executive projects, or more detailed scoping measures, need to be carried out either before or after these modeling exercises. The following two cases are worth highlighting:

- **Projects and cost estimates for upgrading existing corridors,** based on actions, recommendations, and prioritization of the work performed.

- **Projects and cost estimates related to the expansion of the cycle path network** in order to implement and complete its proposed expansion.

## 8.4 | BUDGET FORECAST

Resources need to be guaranteed in the MSP budget for commencing the Smart mobility Program immediately, based on the above recommendations. A task force is recommended to ensure inclusion of the 2023 budget forecast. Two types of resources are required: (1) for complementary preparatory studies to support subsequent investments; and (2) for current investment.

## 8.5 | BIDDING NOTICES FOR INVESTMENTS IN INFRASTRUCTURE OR SYSTEMS AND CONSULTANCIES

Some of the actions are ready to be implemented, and specifications need to be prepared for launching the bidding process. The tendering documents need to include at least the following:

- **Studies in general:** Internal discussions need to take place and a timetable prepared for contracting the studies, starting immediately with the priority studies (see chapter 10 recommending organizing teams for taking the plan forward).
- **Modernization of existing corridors:** Given the levels of detail obtained in the Activity 4 study on bus corridors, the corridors urgently requiring modernization as a high priority could now have the specifications of their public contract bidding notices prepared.
- **Cycle path works:** Scoping contracts for cycle paths must take into consideration the recommended prioritization of this initiative, as well as the resources needed for carrying out priority deployments.
- **SIGMA, SMGO, Data Lake, and MaaS plataform (phases 1, 2, and 3):** These widely discussed systems could immediately be the subject of new bidding exercises, to include the scope and design of their logical and physical architecture as well as their actual development and deployment.


CHAPTER
9

# 9 | FINANCING AND IMPLEMENTATION

While the preparatory stage for any project (planning, studies, creating benchmarks, etc.)—however well-endowed with robust data fundamentals—is of major importance, successful transformation of the project components into mobility actions and systems to consolidate smart public policies is a task requiring an objective strategy and political commitment.

The outcomes of the Smart Mobility Program, however comprehensive it may be, are limited in terms of depth and detail, although the technical products developed during the Program serve to highlight its importance.

This chapter points to aspects of actions and initiatives needed for ensuring gradual and coordinated progress toward a smart São Paulo. Key aspects include: (1) building the Program's coordination and development teams, including social participation; (2) determining the priority of the proposed actions, services, and systems; (3) identifying sources of funds for the necessary investments; and (4) detailing and validating a logical deployment schedule.

The following subsections contain a nonexhaustive list of recommended actions for implementing the Program as an integrated Smart Cities Program.

## 9.1 | STRUCTURING THE TEAMS AND MANAGEMENT MODEL

The first requirement is self-organization for coordinating an initiative involving the implementation of different types of actions strongly connected to one another. This involves building teams and establishing control mechanisms and transparent communication channels to ensure that all stakeholders can access and participate in the Program.

Four topics are highlighted here for discussion and agreement in the São Paulo City Hall (Prefeitura Municipal de São Paulo, PMSP) prior to activating the development of the Program:

- **Creation of a Project Management Unit** with teams to work on project detail and supervision, implement the proposed interventions, and monitor them subsequently.
- **Definition of the dynamics of the participatory process and communication** channels to guarantee the transparency and effective coordination of actions, and ensure that the community helps validate the proposals and is able to monitor the implementation and operation of services.
- **Definition of collaborative mechanisms between institutions**, more specifically between the various PMSP bodies and those engaged in mobility and urban space development in other municipalities of the Metropolitan Region, and between entities in the state of São Paulo (Metropolitan Transport Department [STM], Metrô, São Paulo Metropolitan Train Company [CPTM], São Paulo Metropolitan Urban Transport Company [EMTU], Transport and Logistic Secretariat [SLT], etc.).
- **Selection of Program management tools**, with platforms based on innovative technologies for real-time and simultaneous access by various groups of users, and equipped with customized interfaces for consulting selected indicators and data, with references for decision-making at all the required levels.

## 9.2 | PRIORITIZATION OF ACTIONS

The established organizational structure needs a benchmark for developing and implementing the proposals contained in the Program. This benchmark, in turn, must be based on the prioritization of actions determined as a result of a multicriteria assessment by the stakeholders involved.

Prioritization involves considering the level of precedence of the various actions, avoiding wasted effort and resources or repeat work, and promoting synergy by following the correct sequence of Program deployment. Among the actions that can be developed in parallel it is also important to evaluate those with the greatest potential of return in terms of time or benefits, and to prioritize the most advantageous at any given moment. While it is important to see the plan as a mechanism for generating outcomes, it is also essential to have a strategy for detailing each initiative so that it can impact positively on a broader public or private business plan.

Using the benchmarks indicated it is possible to define and apply a multicriteria evaluation for the final prioritization of actions. This criteria must be regularly validated throughout the development, implementation, and operation of the Program.

In summary, the following steps are recommended to determine the prioritization of actions:

- Validation of the links between the initiatives related to the various projects in the Program, and identifying their necessary order of precedence.

- Discussion and a study to compare different levels of effort required to determine the prioritization of actions implemented, and the identification of necessary complementary or additional elements related to each of the projects. It is worth mentioning here the importance of inclusive mobility as a prominent benchmark when prioritizing actions.

- Establishment of the methodology and time frame of the required business models, focusing on preparing specifications for the regulatory and hiring procedures for works, operators, managers, and other service providers, as well as enabling more accurate estimates of the investments needed.

- Determining through discussion a multicriteria evaluation model, and applying it to define the prioritization of Program actions, while taking account of the frequency and procedures required for reviewing and validating the model throughout the duration of the Program.

- Selection of priority actions as a symbolic gesture at the start of the Program and as a good strategy for bringing it to public attention. Effective hiring of implementation and operation services could be seen as a pilot action for verifying the Program's control mechanisms, analytical indicators, and quantification of benefits, as well as highlighting the lessons learned to assist with the later actions.

## 9.3 | FINANCING SOURCES

After the proposals have been prioritized and the dependency relationship between the initiatives clarified, it is possible to proceed to detailing actions to estimate the amount of investment and the identification of financing sources needed for implementation. As mentioned, it will be necessary to contract studies, projects, and models that make it possible to quantify and analyze alternatives, and to select the best strategy for financing the actions designed for the Program in the coming years.

The following steps are recommended in order to identify the required resources:

- Development of business models according to the deployment phases of the Program in general, followed by specifically contracting some of the more individual models.
- Continue with the gradual detailing of the Program budget, indicating the required cash flow and respective investments, ensuring that the requirements are tailored to the budget preparation process conducted by the Municipality of São Paulo (MSP), in order to ensure that an official stamp of approval is given to the measures to facilitate future contracts.
- Take a continuous, gradual approach to identifying alternatives for public financing and/or private sector participation. Activate the necessary procedures to trigger receipt of such resources, and gradually include Program projects in the list of actions being implemented.

This mechanism for carrying out detailed analysis and activating executive processes must be incorporated into the monitoring regime suggested in subsection 9.1 (team structuring and the management model), as a way of highlighting the fact that the Program is active and alive, constantly evolving and improving.

## 9.4 | IMPLEMENTATION ROADMAP

The implementation of recommendations as varied as those recommended by the Program requires the definition of two types of scheduling: (1) a schedule of the management plan; and (2) a schedule detailing the plan's components and actions.

Most of the products developed in the Smart Mobility Program mentioned how they were to be

implemented in one way or another. Some of the proposals, particularly those listed in Pillar 1, refer to investments in infrastructure or operational systems designed to enhance transport services and improve urban mobility. The other components of the Program outlined in Pillar 2, refer to cross-cutting themes that need to be considered in all the investments proposed under Pillar 1.

The implementation schedule mainly refers to infrastructure projects and operational systems in which the incorporation of the specified concepts for the effectiveness of inclusive policies must be guaranteed with a view to contributing to a mobility system for all, that is, "leaving no one behind."[46] Thus, the various proposals arising from the studies development and deployment schedules were based on the recommendations made for the MSP.

To form a preliminary linkage between the proposed actions a schedule was prepared to serve as an example of the intended development of the integrated plan (Figure 35). It is suggested that the detailing and continuous monitoring of this type of schedule should be done within the scope of the management tools suggested in subsection 10.1 referring to team structuring and the management model.

It should be noted that the schedule shown in Figure 35 (blue bars) refers to larger investments where the sources of funds need to be indicated in detail in order to sharpen the Program's implementation plan.



46 Implementing the commitment to "leaving no one behind" in cities: what it means in practice. Cities Alliance. Available at: <https://www.citiesalliance.org/sites/default/files/leave-noone-behind-final_0.pdf>

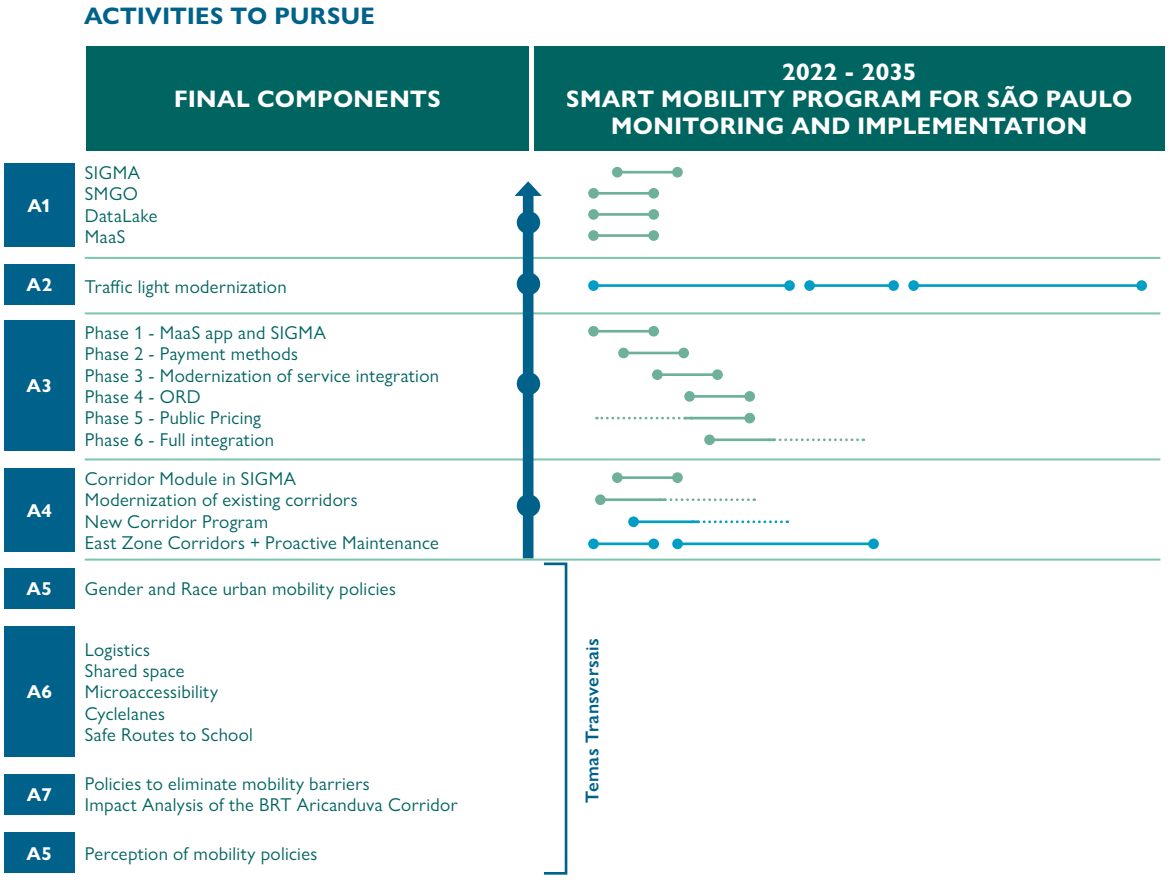



**Figure 35 | Example of the Program implementation schedule. Source: World Bank (2022).**

In addition to the schedules for the actions, a timetable is also needed that sets out the dynamics of the development and monitoring of the Program as a whole, containing the actions mentioned in the first three subsections of this chapter. The suggested starting point could be the discussion of the adjustments needed to determine PMSP's internal schedule of actions that might lead to the hirings required for the planned deployments (Table 5).

| Topic | Description | Phase 1<br>1 month | Phase 2<br>2 months | Phase 3<br>3 months | Phase 4<br>Permanent |
|---|---|---|---|---|---|
| **Structuring teams and the management model** | Creation of the Project Management Unit | ■ | | | |
| | Definition of participatory process and communication channels | ■ | | | |
| | Definition of control mechanisms between institutions | ■ | | | |
| | Selection of the Program Management Tool | ■ | ■ | | |
| **Prioritization of actions** | Interdependence relationship between actions | ■ | | | |
| | Preliminary prioritization | ■ | | | |
| | Chronology of models required | ■ | ■ | | |
| | Multicriteria evaluation model<br>Final prioritization | ■ | ■ | | |
| | Symbolic pilot action to start deployment of plan | | ■ | ■ | ■ |
| **Identification of funding sources** | Plan modeling | | | ■ | |
| | Specific action modeling | | | ■ | ■ |
| | Budget and cash flow | | | ■ | ■ |
| | Financing mechanisms | | | | ■ |
| **Chronology** | Preliminary timetable for actions of the plan | ■ | ■ | | |
| | Plan management (this table) | ■ | ■ | ■ | ■ |

**Table 5 | Proposed schedule for the Program implementation plan. Source: World Bank (2022).**

# CHAPTER 10

# 10 | CONCLUSIONS

The World Bank team is grateful for the excellent work of each and every one who collaborated in putting the Smart Mobility Program together. Thanks go to the UK government and its technical team for financing the Program, as well as to our main partner and beneficiary, the São Paulo City Hall (Prefeitura Municipal de São Paulo, PMSP), and the different secretariats involved in the studies. We are grateful in particular to all the officials who shared their commitment and competence in the technical discussions of around 90 reports produced, which confirmed the initiative as a great success, benefiting not only the City of São Paulo, but also serving as a benchmark for other cities around the world.

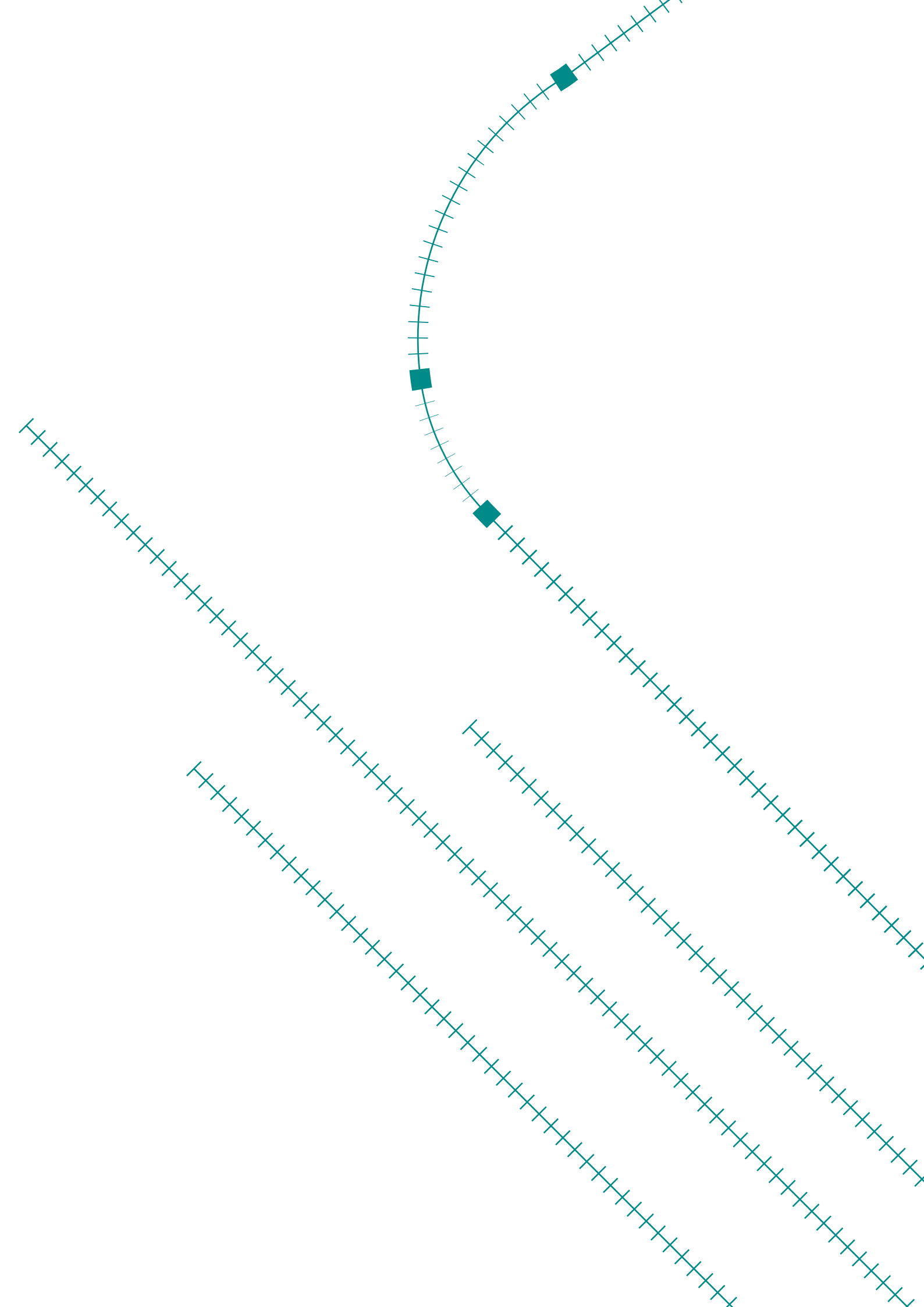
This work embodied technical excellence thanks to the commitment of everyone who was convinced that dialogue and joint work produces positive solutions in tune with local needs, thus validating the success of the Program.

The World Bank team wishes to continue the partnership with the PMSP in project implementation, with a view to the projects becoming milestones. We believe that working and learning together is the way forward. Faced by challenges such as the electrification of transport, mobility digitalization, and the climate emergency, we believe that we can learn from this opportunity to continue working together, maturing technically, focusing on topics of importance to society, working in multidisciplinary teams with diverse approaches, in a bid to understand and solve in a variety of ways the problems of those who live in the city.

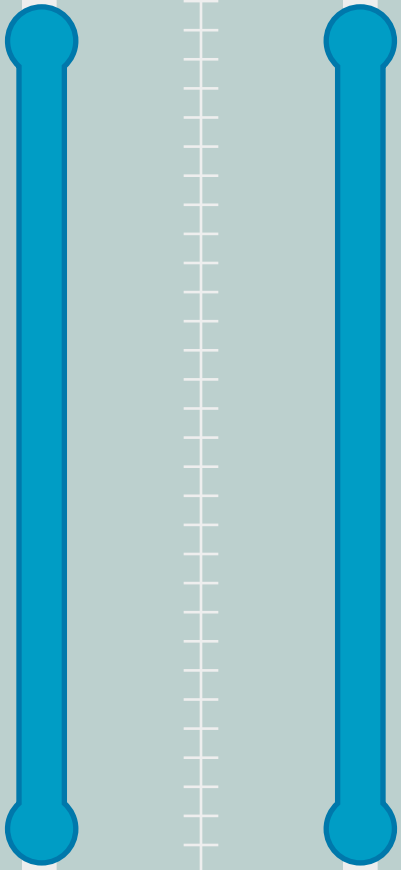
Our thinking on smart mobility for São Paulo should not be limited to the benefits of the latest digital tools but above all consider the many different beneficiaries of smart mobility: pedestrians, cyclists, people with disabilities, children, the elderly, women, black and indigenous people, people with special needs, and the most vulnerable segments of the population.

Finally, given that the Program was committed to introducing innovative ideas to the PMSP, it is apparent that its team evolved significantly from the beginning to the end of the Program. The progress on topics such as Mobility as a Service, the management and operation of buses based on big data and artificial intelligence (considering minorities and women first), was evident throughout the joint development of the Program, and reinforced by the wide-ranging studies that were the key to paradigm shifts within the PMSP and its excellent teams of technicians and managers.

In short, we believe that the lessons learned and recommendations outlined here go beyond mere reports. They were absorbed by the PMSP technical team and will be reflected in future actions and investments, including in the Aricanduva Bus Rapid Transit Corridor. The PMSP has thus attained a leadership position, with full technical capacity to carry out the necessary changes in transport planning to transform São Paulo into an increasingly smart and inclusive city.



# CHAPTER



# 11 | ANNEX

## ANNEX I

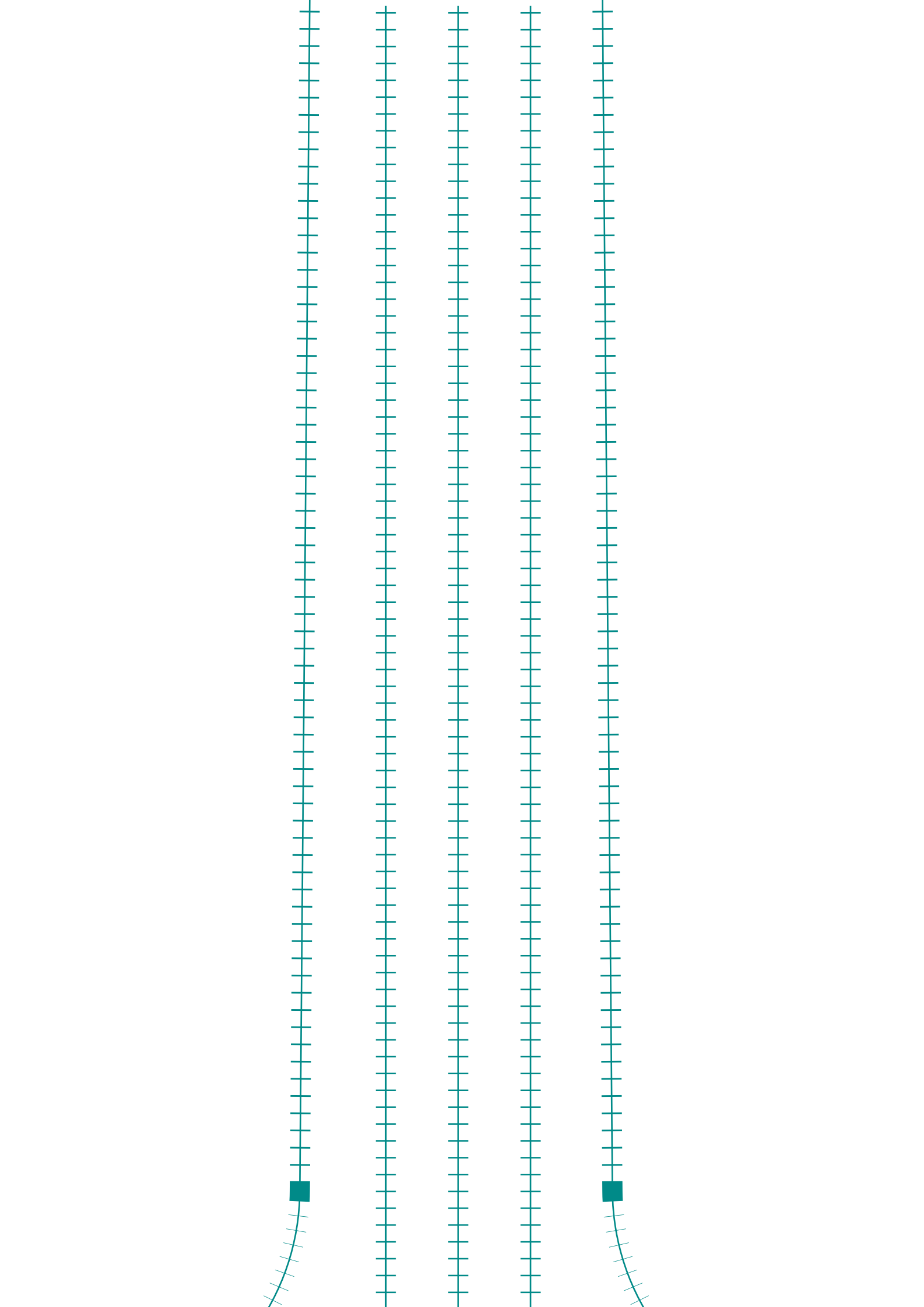
Table A.1 describes the contents of the studies produced under the Smart Mobility Program.

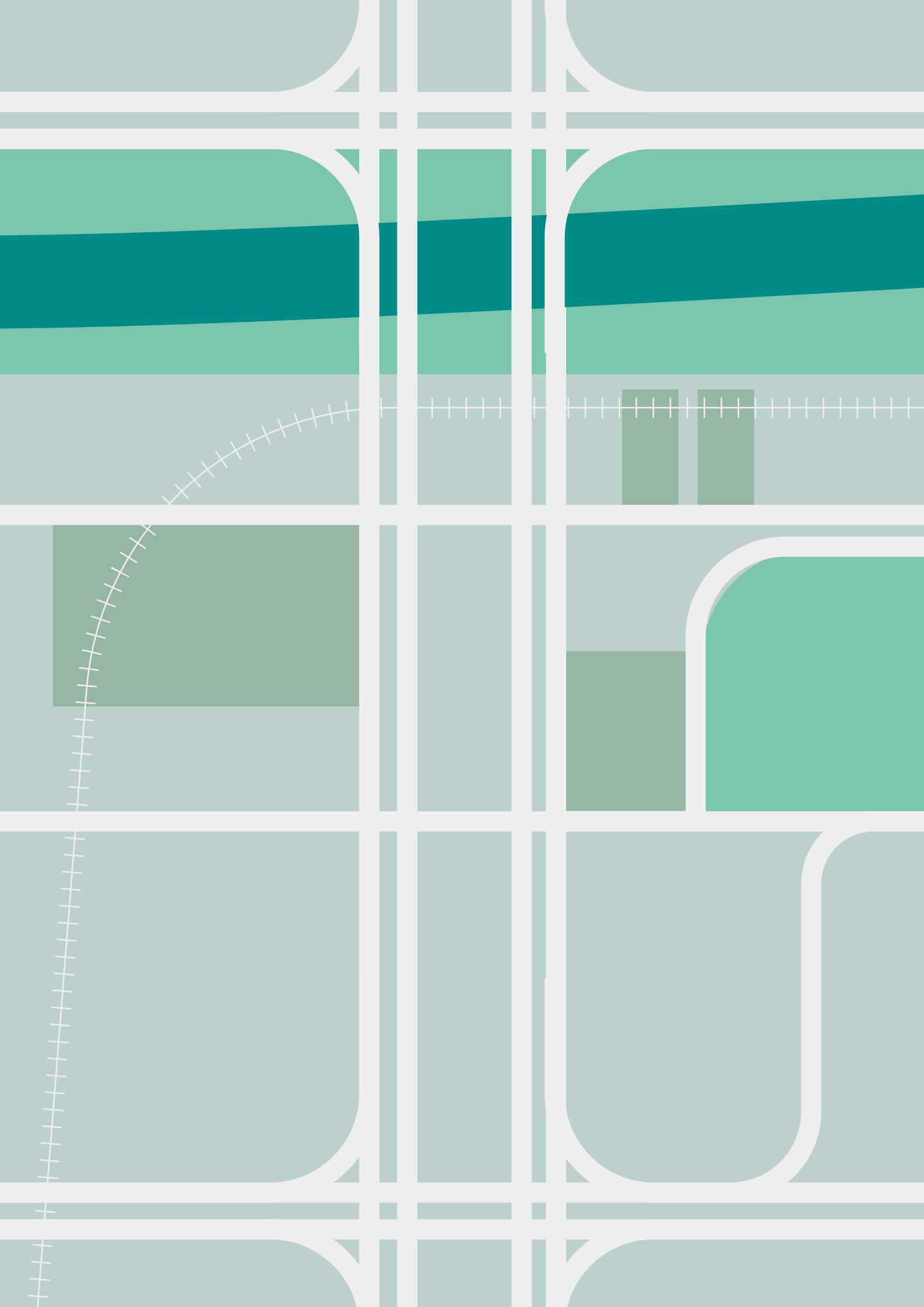
| | Activity | Product | Object | Institutional partners |
|---|---|---|---|---|
| PILLAR 1 | **A1 — COP**<br>EURECAT, TMB, MCRIT, CONCREMAT<br>Bidding | P1 | Work plan | SPTrans |
| | | P2 | Institutional governance benchmarking | SETRAM |
| | | P3 | MaaS technologies benchmarking | SMT |
| | | P4 and P5 | SP diagnosis and survey requirements for the OCC | |
| | | P6 | Conceptual model for systems and information | |
| | | P7a | Reccomendations for the Advanced Planning System (SIGMA) | |
| | | P7b | Reccomendations for the Operational Monitoring and Control System (SMGO) | |
| | | P8 | Arquitecture integration proposal for the new COP | |
| | | P9 | Implmentation plan for long term MaaS OCC and OMMS strategy | |
| | | P10-pt | Executive summary (in Portuguese) | |
| | | P10-en | Executive summary (in English) | |
| | **A2.1 — Simulation**<br>Gabriel Pereira Caldeira, Luca Di Biase, Maria Inês Garcia Lippe<br>STCs | P1 | Final report | CET |
| | | P2-pt | Executive summary in Portuguese | SMT |
| | | P2-en | Executive summary in English | SPOBRAS |
| | **A2.2 — Traffic lights and 5G**<br>SCHLOTAHUER & WAUER, TRANZUM, STEER, MRK GROUP<br>Bidding | A-pt | Work plan (in Portuguese) | CET |
| | | B-pt | International benchmarking (in Portuguese) | SMT |
| | | C-pt | Diagnosis (in Portuguese) | |
| | | D-pt | Technological options (in Portuguese) | |
| | | E-pt | Recommendations for SP (in Portuguese) | |
| | | F-pt | General recommendations for smart cities (in Portuguese) | |
| | | G-pt | Executive summary (in Portuguese) | |
| | | A-en | Work plan (in English) | |
| | | B-en | International benchmarking (in English) | |
| | | C-en | Diagnosis (in English) | |
| | | D-en | Technological options (in English) | |
| | | E-en | Recommendations for SP (in English) | |
| | | F-en | General recommendations for smart cities (in English) | |
| | | G-en | Executive summary (in English) | |
| | **A3 — Governance**<br>FUNDAÇÃO GETÚLIO VARGAS<br>Bidding | PA | Work plan | SPTrans |
| | | PB | Diagnosis | SETRAM |
| | | PC | Recommendations for implementing MaaS in SP | SMT |
| | | PD | General recommendations for implementing MaaS | |
| | | PE-pt | Executive summary (in Portuguese) | |
| | | PE-en | Executive summary (in English) | |
| | **A4 — Corridors**<br>LOGIT –<br>Bidding<br>Paulo Fonseca- STC | P0 | Inception report | SPTrans |
| | | P1 | Database consolidation | SPObras |
| | | P2 | Corridor classification methodology | SMT |
| | | P3 | Implementation of the classification Methodology | SETRAM |
| | | P4 | Action plan | |
| | | P5-en | Executive summary (in English) | |
| | | P6 | Proactive corridor maintenance | |
| | | P7 | Recommendations for maintenance and implementation of corridors | |

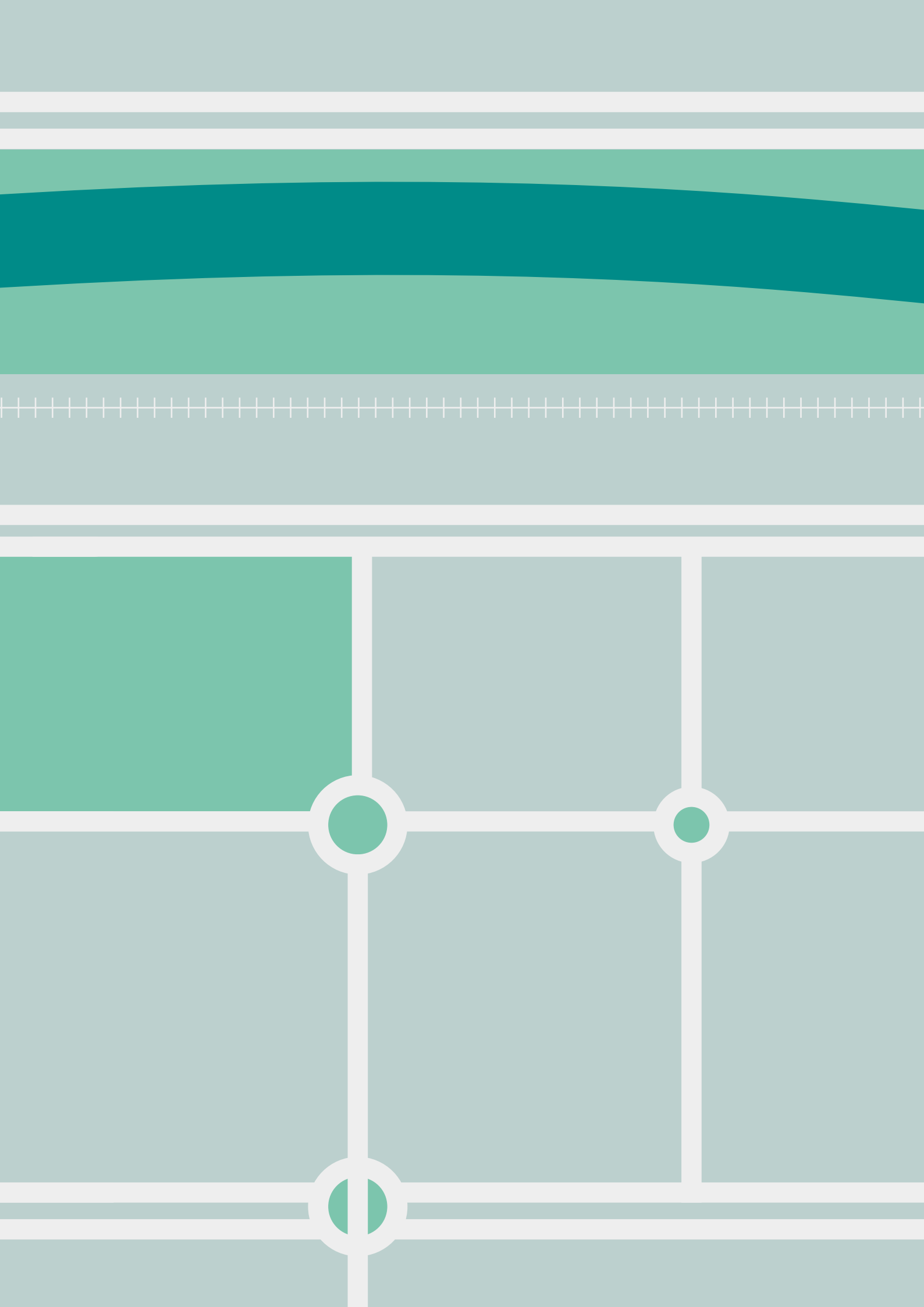
| | Activity | Product | Object | Institutional partners |
|---|---|---|---|---|
| PILLAR 2 | **A5.1 — Gender and mobility**<br>ITDP, CEERT<br>Bidding | B1 | Complementation of the baseline analysis | SPTrans |
| | | B2 | Awareness course on gender and race issues in transport | CET |
| | | C1 | Pilot proposal for the unification of service protocols | SETRAM |
| | | C2 | Training for the pilot proposal | SMT |
| | | D1 | Diagnosis of the promotion of women in transport hiring | METRÔ |
| | | D2 | Action plan | CPTM |
| | | E-en | Executive summary (in Portuguese) | |
| | | E-pt | Executive summary (in English) | |
| | **A5.2 — Safety perception**<br>SAFETIPIN<br>Direct hiring (SSJ) | 1 | Work plan | SPTrans |
| | | 2 | Methodology | CET |
| | | 5 | Final report | SPObras |
| | | | | SMT |
| | **A5.3—Terminals**<br>COMAP – Bidding<br>Debora Toledo Gonçalves, Eliana Pires de Souza - STCs | 1 | Work plan | SPTrans |
| | | 2 | Proposal of indicators | SETRAM |
| | | 3 | Security perception in terminals | |
| | | 4 | Ethnographic routes | |
| | **A6.1 — Urban logistics**<br>SCAMBO<br>Direct hiring (SSJ) | C | Final report | CET |
| | | F | Cyclologist pilot manual | UKPP Team |
| | | SE-pt | Executive summary (in Portuguese) | SMT |
| | | SE-en | Executive summary (in English) | |
| | | | Demo day | |
| | **A6.2 — Shared streets**<br>FUNDAÇÃO GETÚLIO VARGAS, VITAL STRATEGIES, REDES<br>Bidding | A | Work plan | SMT |
| | | B1 | Policy analysis | CET |
| | | B2 | Benchmark and case study | SETRAM |
| | | C | Externalities | SPTrans |
| | | D | Simulations | |
| | | E | Recommendations | |
| | | F | Executive summary (in Portuguese) | |
| | **A6.3 — Microaccessibility**<br>STUDY+1<br>Bidding | D | Final report | SMT |
| | | | | SMPDE |
| | | | | SEHAB |
| | | | | CET |
| | | | | SPTrans |
| | **A6.4 — Cycle lanes**<br>Jeroen Buis, Claudio Edmundo Olivares Medina, Lucas Eduardo Araujo de Melo, Flavio Soares de Freitas, Debora Toledo Goncalves e Gabriel - STCs<br>COMAP, DECISIO – Direct contracting (SSJ) | A | Diagnosis and recommendations | CET |
| | | B | Social cost-benefit analysis | SMT |
| | | | | SETRAM (BikeSP) |
| | | | | |
| | **A6.5 — Accessible school routes**<br>Eliana Pires de Souza<br>Úrsula Correia Troncoso | 1 | Action plan | CET |
| | | 2 | Benchmarking solutions to improve mobility of children and care-givers | SMT |
| | | 3 | Identification of challenges and needs | SMPD |
| | | | | SPTrans |

| | Activity | Product | Object | Institutional partners |
|---|---|---|---|---|
| PILLAR 2 | **A7.1 — Barriers**<br>MCRIT, EURECAT, SYNERGIA<br>Bidding | A | Work plan | SPTrans |
| | | B | Benchmark | SPObras |
| | | C | Secondary data analysis for barrier identification | SMT |
| | | D | Methodology for data collection | SETRAM |
| | | E | Recommendations | CET |
| | | F | Executive summary (in Portuguese) | |
| | **A7.2 — Baseline**<br>MCRIT | 1 | Work plan | |
| | | 2 | Final report | |
| | | 3 | Baseline BRT Aricanduva | |
| | **A7.3 — Social interest housing**<br>STCs<br>Camila Maleronka, Fernando Souza, Fernando Massonetto | 1 | Análise de pre-viabilidade em empreendimentos de habitação social associados ao Metro de SP | Cia do Metropolitano de SP |
| | | 2 | Analise de Mercado | |
| | **A8.1 — Communication survey**<br>Big Data Idea<br>Bidding | AeB1 | Digital mapping and narratives—Press | SPTrans |
| | | AeB2 | Digital mapping and narratives—Social | SETRAM |
| | | C | Results of discussions and focus groups | SMT |
| | | D | Opinion survey | |

Note: OCC = Operations and Control Center; CET = Traffic Engineering Company; COP = SPTrans Operations and Control Center; CPTM = São Paulo Metropolitan Trains Company; ITDP = Institute for Transportation and Development Policy; MaaS = Mobility as a Service; SEHAB = Municipal Housing Department; SETRAM = Executive Secretariat for Transport and Urban Mobility; SIGMA = Mobility and Accessibility Georeferenced Information System; SMGO = Operational Management and Monitoring; SMPD = Municipal Secretariat for Persons with Disabilities; SMT = Department of Mobility and Traffic; SP = São Paulo; SPTrans = Sâo Paulo Transportes; STC = Short Term Consultant; UKPP = United Kingdom Prosperity Program.





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