WRI BRASIL

DAY ONE OF OPERATION

QualiÔnibus: Bus Service Quality Program

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Rio de Janeiro

DAY ONE OF OPERATION

QualiÔnibus: Bus Service Quality Program

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FOREWARD

The future of urban mobility needs to rely on public transport. The last two decades have seen individual transport grow over public transport in Brazil. In other words, a large portion of the population in big cities stopped commuting by bus in favor of cars and motorcycles. It is not a coincidence that the emissions of greenhouse gases, the main cause of global warming, grew 192% in the same period. This trend means worse traffic congestion, worse air pollution rates, and a poorer urban mobility experience as a whole. It also prevents accomplishing the environmental goals that Brazil has committed itself to.

Sustainable and low-carbon development requires enhancing the use of public transport, a service still relied upon by the majority of the population and that has the potential to transform urban mobility. However, when individuals are faced with transport options, quality of service is key to their decision. Therefore, improving the quality of public transport is key to broader mobility and sustainability goals.

The QualiÔnibus Program, developed by WRI Brasil with support from FedEx Corporation, aims to attract and retain public transport customers, improve urban mobility and foster more sustainable cities. This publication is one of the five QualiÔnibus tools and seeks to take advantage of a strategic moment for building a positive and reliable image of the system: the first day of operation of new public transport services.

This updated version of Day One of Operation offers improved content provided by the experiences and feedbacks coming from the transport systems of three Brazilian cities that have applied the methodology: Belo Horizonte, Brasília and Rio de Janeiro.

The implementation of Transantiago (Santiago, Chile) and the expansion of TransMilenio (Bogotá, Colombia) provided examples of common situations at the beginning of the operation that can happen in different phases of the operation of any system in the world. The lessons resulted from several challenges, from infrastructure to communications.

Day One of Operation targets transit agencies as well as bus operators. The guide presents 20 elements to the development of operational manuals and the contingency procedures. In total, it frames a solid toolkit to the standardization and quality through the execution of operational processes.

WRI Brasil understands that QualiÔnibus Program is effective in creating a positive environment that helps Brazilian cities create a better pubic transport system, which brings a balance to the choice between individual and public transport. Safety and reliability attributes play key roles in bringing more people to sustainable transport.

Luis Antonio Lindau

Director of the Cities Program - WRI Brasil

Rio de Janeiro

QUALIÔNIBUS BUS SERVICE QUALITY PROGRAM

QualiÔnibus Program's purpose is to improve the quality of public transport services by bus. Developed by WRI Brasil with the financial and conceptual support provided by FedEx Corporation, the Program aims to attract and retain customers, improve urban mobility and make transport in cities more sustainable by creating a virtuous cycle of benefits.

QualiÔnibus consists of five tools for public transport providers, all centered on assessing and improving the performance of public transport that translates into improved perceptions of transport quality for system users.

QUALIÔNIBUS TOOLS

QUALIÔNIBUS DAY ONE

Reduces the risks associated with beginning new operations within the bus system. Day One also promotes the development of operational manuals and contingency procedures.

QUALIÔNIBUS SATISFACTION SURVEY

Reduces the risks associated with beginning new operations within the bus system. Day One also promotes the development of operational manuals and contingency procedures.

QUALIÔNIBUS QUALITY INDICATORS

Assesses the improvement of key quality indicators towards a quality public transport system. Tying the indicators towards specific interventions allows the group to formulate best practices through the benchmarking process.

QUALIÔNIBUS BENCHMARKING GROUP

Focuses on promoting the most effective actions towards quality public transport from the customers perspective by exchanging experiences among cities and getting insights from the survey and quality indicators through benchmarking process.

QUALIÔNIBUS SAFETY FIRST

Matches professional driver training with the development of an Integrated Road Safety Plan that improves the operation of bus systems. The Plan consists of three complementary stages: (i) training focused on road safety, (ii) creation of continuous professional development program for the drivers and (iii) analysis and impact assessment of traffic crashes over time.

Belo Horizonte

EXECUTIVE SUMMARY

HIGHLIGHTS

- The challenges and lessons of the implementation of a new bus system in Santiago (Chile) and the expansion of the system in Bogotá (Colombia) demonstrate the importance of planning in advance of the first days of operation.

- This guide is designed to meet the demand of transit agencies and operators of public transport systems, who need to develop operational manuals and contingency procedures adapted to bus priority systems.

- Including the 20 suggested elements outlined in this report can help agencies and operators reduce and manage risks when planned in an integrated way before launching a new bus system.

- The methodology in this report facilitates planning and management processes that will provide greater security and efficiency to the public transport system. It aims to reduce the risks associated to launching new bus systems by supporting the coordination of the activities that need to be done and the communication among the parties involved.

CONTEXT

Along the implementation of new transport systems, Latin American cities face challenges that can be overcome with good planning. Cities like Santiago and Bogotá, mentioned in this guide, faced these challenges during different phases of the operation of their public transport systems. Looking for ways to overcome these challenges can help to build a positive image for the system.

Creating operational manuals is a common practice in several sectors. Large companies, for example, use them to guarantee the correct and standardized execution of operational procedures and, thus, to ensure quality of service. In the transport sector, it should not be different. Although some areas have already made great progress, such as logistics and rail transport, in the bus-based public transport services the practice is still emerging.

A successful launch is essential for building a reliable image of a new or expanding system. In the customers first experience with a new or altered service, they must promptly notice an improvement in the quality of service compared to the previous scenario. The first ride must dispel any negative perceptions that customers have been exposed to – for example, in cases where building the system required major civic works, causing disturbances to the neighboring population. To ensure a positive image, one must be prepared to overcome any challenges at day one.

ABOUT THE GUIDE

Day One of Operation presents usual challenges during the implementation of transport systems and a systematic approach for developing operational manuals and contingency procedures. Chapter 1 portrays the challenges and lessons learned in the implementation of Transantiago and in the expansion of TransMilenio. The two cases show the importance of comprehensive and detailed planning to ensure a good start of operations. Chapter 2 presents, in an objective and systematic way, 20 consolidated elements from different manuals produced in Latin America that are key to developing an operational manual. A brief description of these elements is shown in Figure ES-1. Through the establishment of plans, processes and procedures, the development of the manual assists the planning of the Day One of Operation of bus priority systems.

A well-prepared operational manual can be the basis for the Quality Management System of the public authority and the bus operator. This good practice can be the first step to meet documentary requirements of ISO Standards, making the company eligible for certifications that also allow it to be benchmarked with its peers.

The target audience of this guide includes transit agencies as well as bus operators. Other entities that also in charge for the operation of transport systems can also use this guide, and their involvement is essential to a successful start of operations.

This edition is an update of the publication launched in 2014. It incorporates improvements based on feedbacks received and the application of the methodology in Belo Horizonte, Brasília and Rio de Janeiro.

Figure SE-1 | **Chapters of the operational manual**

1. MANAGEMENT AUTHORITY AND GENERAL REGULATIONS
Responsibilities of the entities associated with the transport system

2. MANUAL'S PURPOSE
Description of the purpose of the manual

3. MANUAL'S SCOPE
Main actors to whom the manual is addressed

4. RESPONSIBILITY
Who produces, reviews and approves of the manual

5. DEFINITIONS
Terminology used in the operational manual

6. SYSTEM'S OBJECTIVES
Description of the goals and objectives of the transport system

7. SYSTEM'S FLEET
Description of the physical infrastructure that makes up the system

8. SYSTEM'S FLEET
General features of the fleet

9. OPERATION
Description of the operational parameters of the system

10. DRIVERS
Requirements for drivers

11. ROUTE PLANNING SYSTEM
Description of system for planning service

12. FLEET MANAGEMENT SYSTEM
Description of the fleet management system

13. TICKETING SYSTEM
Payment system of the transport service fares

14. CUSTOMER INFORMATION SYSTEM
Description of the customer information system

15. ROAD SAFETY
Description of the road safety attributes of the system

16. KEY PERFORMANCE INDICATORS
Indicators of the health of the transport system

17. CONTINGENCY PROCEDURES
Definition of the contingency procedures

18. DETOUR PLANS
Operational detour plans due to interruptions of the bus-dedicated lane

19. FORMS
Structure of documents and forms used to document the transport system operation

20. ATTACHMENTS
Other documents related to the manual

Source: developed by the authors.

This guide is part of the four-publication set of QualiÔnibus Program:

- Day One of Operation;
- Quality Management Tools;
- Satisfaction Survey Manual;
- Safety First.

WRI Brasil works in partnership with governments, companies, the academy and civil society to promote solutions that foster sustainable development. Through publications and guides like this one, it strives to disseminate relevant information so that decision makers can effectively implement projects and public policies that improve quality of life.

CONCLUSION

This guide aims to highlight important planning elements of public transport systems. By listing 20 important elements regarding planning, implementation and operation, the publication offers a comprehensive assessment of the transport system. This way, it is possible to properly plan and verify items that sometimes end up omitted or overlooked, and the system has a greater chance of success at its inauguration.

A well-articulated planning process at the conception of the system will ensure that technical and political challenges are overcome. Lessons learned from the experiences of Santiago and Bogotá show the importance of carefully planning all items that need to be prepared for the inauguration of the system, so that, even if challenges occur, it is possible to address them.

Transport systems with data and information compiled in manuals and procedures are better prepared to manage incidents. This qualifies and standardizes the knowledge necessary to ensure the operation even in risky situations, what contributes to a positive image of the system.

To develop an operation manual and contingency procedures, different quality-related factors of the transport system must be taken into account. QualiÔnibus Program's publications help to build a high quality public transport based on four aspects: good operation, safety, continuous monitoring of system indicators and customer satisfaction.

RECOMMENDATIONS

The city must define the most appropriate institutional arrangement to manage the planning, implementation and operation of its bus priority system. Decision makers must be able to delegate responsibilities — including the development of the operational manual and contingency procedures —, once there are other projects related to the transport system that also need to be executed, involving other instances in the city.

The entity responsible for the management of the transport system must provide information so that the population is aware of the changes and benefits that will come with the new system. The entire population (regardless of their use of public transit), interest groups, and the media, need information about the changes that the public transport system will undergo in advance.

Beyond building the infrastructure, a successful launch requires that the entities involved can anticipate expected and unexpected incidents. The operation manual and the contingency procedures enable an agile and coordinated response in case of any incident. Internally, it is necessary to define in detail the responsibilities of each one involved in the project and allocate the necessary technical and financial resources.

The creation and dissemination of manuals and procedures must take place before the inauguration or expansion of the transport system. However, systems already running that wish to better structure their operation can also use this guide. The recommendation is that the manual is finished six months before the system starts to operate. These materials must be developed and often reviewed and updated, so that they are a useful tool for all actors involved in the operation of the system.

Curitiba

Rio de Janeiro

INTRODUCTION

Starting operations off well is critical for building a positive and reliable image of public transport. In his or her first experience with the new service scenario, the customer must notice an improvement in the quality of service. The first trip is an opportunity to revert any negative perceptions related to the implementation of the system – for example, in cases where the system required major construction that caused noise or traffic disturbances to the neighboring population. In addition, new services are an opportunity to make public transport attractive to users of individual motorized transport. Their continued patronage can be a major factor of success for the system — and many of these customers can only give it one chance. A negative perception by new customers may spread quickly, which may dissuade others in the community from using public transport. On Day One, public authorities will usually ride the new system to inaugurate it, which will receive wide attention from the local media. To ensure a positive image, it is necessary to be prepared to overcome any challenges.

Both customers and non-customers need to be aware of changes and benefits that will come with the new system. The entity responsible for the management of the transport system must provide information to the population as well as to interest groups, especially the media, regarding the changes that the public transport system will undergo (EMBARQ, 2011). An assessment before, during and after the inauguration is necessary to clarify any issues that remain about the system and to check what is correctly working and what needs to be modified. For this improvement to be continuous and systematic, it is of vital importance to establish indicators to monitor and compare the performance of the system over time to maintain or improve its quality (WORLD RESOURCES INSTITUTE BRASIL, 2018b).

This document aims to make public authorities, transit agencies and bus operators aware of the importance of a successful start of operation. For this purpose, Chapter 1 of this publication presents the experiences of Santiago (Chile) and Bogotá (Colombia) at the beginning of operation and expansion of their systems, highlighting common problems and lessons learned. A literature review of scientific articles and news published by the media allowed the explanation of these two panoramas. Information from professionals who participated in the implementation of both systems was also essential. Chapter 2 brings a guide to the development of the operation manual, listing the main elements necessary to a proper functioning and quality of service. The publication proposes 20 elements based on best practices and operation manuals of the following public transport systems:

- Macrobús, Guadalajara, Mexico (SISTEMA DE TRANSPORTE ELÉCTRICO URBANO, 2012);
- Metrobus, Mexico City, Mexico (GOBIERNO DEL ESTADO DE MÉXICO, 2008);
- Metrobus-Q, Quito, Ecuador (QUITO, [201-]);
- Metrocali, Cali, Colombia (METROCALI, 2010);
- Metropolitano, Lima, Peru (LIMA, 2014);
- TransMilenio, Bogotá, Colombia (BOGOTÁ, 2009; TRANSMILENIO, 2007, 2012).

This edition is an update of the publication launched in 2014, which since then has received comments and incorporated feedback (EMBARQ BRASIL, 2014a). From 2014 to 2016, transit agencies and bus operators of three Brazilian cities applied the Day One of Operation process: Belo Horizonte, Brasília and Rio de Janeiro. These cases enabled the consolidation and refinement of the content in this publication, and two of them are described in chapter 2.

These applications consisted of an immersion in the local system, through meetings with all actors involved, visits to civic works, workshops and activities directly related to the days prior to the inauguration of the systems. In the three cases, knowledge exchange with international experts in the field of public transport management contributed to the review and adaptation of Day One of Operation. In its first version, the publication was specifically focused on Bus Rapid Transit (BRT) systems. This reviewed version provides broader information regarding the 20 elements of the operational manual so that it is possible to apply them to bus-priority systems in general, not only BRTs.

Rio de Janeiro

Curitiba

CHAPTER 1

CHALLENGES IN THE DAY ONE OF OPERATION

A transport system can deeply transform the urban landscape. The implementation of large-scale transport infrastructure comes with opportunities of improvement for urban space that change the way people interact with the city. Due to this high level of complexity, there are several challenges for a successful implementation (LINDAU et al., 2014).

Enhancing a public transport network involves a series of factors. Political commitment is essential for the project to take shape, which then also requires integration with other policy agendas and institutions responsible for transport. Public hearings with local community and negotiations with local businesses who will claim to suffer negative impacts on their results are also important. Moreover, some final adjustments, such as communication with customers and clarity of who will be responsible for the maintenance and daily operations of local stations. Therefore, all actions require full-time effort and dedication from all actors involved.

Cities around the world have succeeded in deploying bus priority systems. However, due to the large number of activities that must be mapped and planned, it is natural that some activities end up receiving less attention than desired. The examples in this chapter present the main challenges commonly faced during the inauguration. It is important to note that, over time, the problems have been addressed. Today, these systems promote a series of benefits, such as reduced travel times, emissions and traffic accidents (EMBARQ, 2013; HIDALGO et al., 2016).

The experiences of Santiago (Chile) and Bogotá (Colombia) in implementing and expanding their systems are described below. A literature review comprehending scientific articles and news published by the media allowed the explanation of the cases. It was also essential the information gathered with professionals who participated of the implementation of the two systems.


Parada
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LA MONEDA
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423 SEGUNDA TRANSVERSAL
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Segunda Transversal
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Santiago

1.1 TRANSANTIAGO

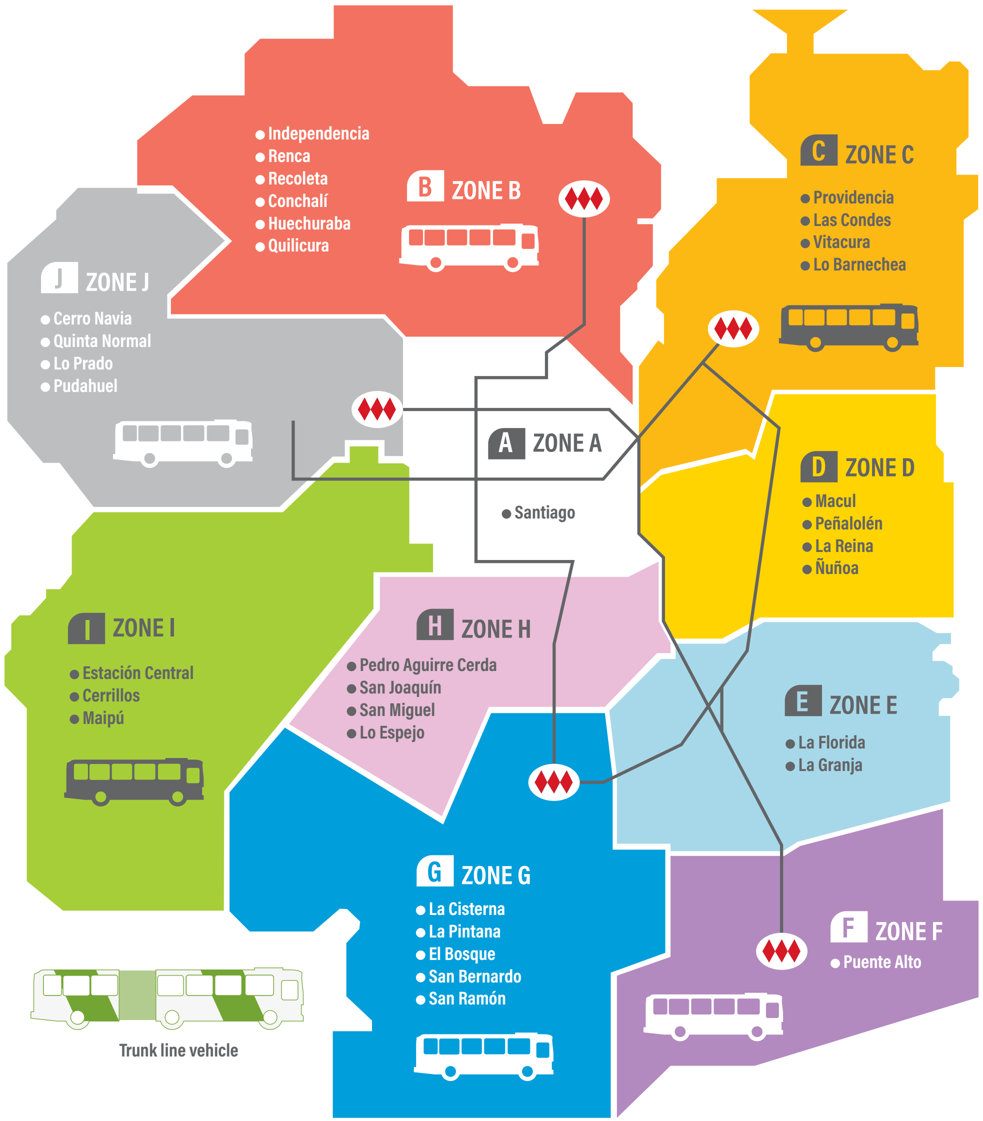
Santiago (Chile) is a metropolis of 5.4 million inhabitants. Its public transport system has 2,790 km of bus routes and 118 km of subway, transporting more than 4.1 million customers per day (WORLD RESOURCES INSTITUTE MÉXICO, 2017). The services have integrated fare (between buses and subway), and both the electronic ticketing (called Bip!) and the operation of the buses are managed by private companies, under government supervision through concession contracts.

After the bus system was considered the worst public service of the city in 2003, public transport in Santiago underwent a process of modernization with Transantiago – the name given to the new bus system in the Chilean capital (MUÑOZ et al., 2009). The planning of Transantiago took several years and faced a series of challenges. Designed as a network of trunk-feeder services, Santiago was divided into ten areas, and in each of them only one company could operate bus lines (Figure 1). The new bus system would have integrated services and fares, with zero or reduced transfer costs and, therefore, it was expected a substantial increase in the number of customers, especially in the subway, which until then did not have integration.

For Transantiago to start operating, a gradual introduction of 1,000 new buses would occur during the first year of transition, so that, initially, the newest buses of the old fleet would still be in use.

The fleet would be equipped with a monitoring system, including GPS, which would make it possible to control the headway between buses and ensure their reliability. In-cash payment would be replaced by a new electronic ticketing system. A private company would manage the system, the distribution of new cards, the provision of recharge points and the technology inside the buses. Some secondary elements, such as the complete implementation of the terminals, would be finalized later.

Figure 1 | **Transantiago structure shows the ten areas in which the city was divided for the operation of the new system**



Source: based on TRANSANTIAGO, [20--].

The contracts with the various bus operators included a contractual fines and awards plan. The money from these penalties would then go to the operators with the best performance. This was determined by metrics on reliability, evasion control and customer satisfaction, for example. Transantiago also included a network of segregated lanes and stations suitable for buses. These would increase the operational speed by reducing interactions with mixed traffic and boarding times at stations (MUÑOZ; GSCHWENDER, 2008).

Transantiago intended to revolutionize the city's public transport in several aspects, especially by increasing the quality of service offered to customers. Since improved quality was a popular concept, the government carried out several advertising campaigns informing how the new system would operate, which further raised expectations. Unfortunately, while the project was still under planning, the government decided to postpone many investments, giving priority to new metro lines (the network increased 20 km between 2006 and 2007, coinciding with the beginning of Transantiago) and subsidizing and favoring a set of new highways in Santiago (MUÑOZ et al., 2009).

The transition period should start one year before the official inauguration of the system. Thus, in 2005, the service concession was awarded to new operators. However, shortly after this agreement the minister responsible for the project resigned. Since there was only a year until the next presidential elections, his successor decided to reduce the pace of work, postponed important decisions until the beginning of the new term and allowed the companies to rent buses, easing the requirement that they must own the fleet.

In March 2006, a new government begun its term. The new Transport Minister did not have technical experience and took three months just to understand the scale of the project, which would open between August and October of that year. As the date approached, only a few of the key elements were ready. The fleet was not equipped with the planned technologies, the electronic ticketing cards had not been distributed nor had their recharge system implemented. In this context, the inauguration was postponed to 2007.

The system started its operation on February 10, 2007. Overnight, there was a new fare structure, a new payment system, and a rerouting of all bus routes for the city.

This process was extremely traumatic and became known as the day of the Big Bang, since a series of elements did not work correctly and people were ill-informed, causing a chaos throughout the city (HIDALGO et al., 2016). Some incentives given to operators were especially damaging, as they did not promote the use of the entire fleet, which later proved to be insufficient.

There was a delay in the implementation of the electronic ticketing system. As a result, on the opening day, a large part of the fleet lacked validators, leading to many complaints from operators. Faced with this scenario, municipal authorities decided to guarantee the fare revenue for three months, regardless of the number of passengers (MUÑOZ et al., 2009). This decision had terrible consequences, as it guaranteed the remuneration of operators according to the demand stipulated in the contract, regardless of the level of service. Thus, the fleet available for the operation was considerably smaller than that required by the public authority. Another aggravating factor was a delay in installing the GPS in the fleet — which would guarantee monitoring trips' compliance — due to a series of elementary management failures by some operators (MUÑOZ et al., 2009).

Additionally, in the first phase of Transantiago, the public authority made some aspects related to the fare more flexible. They eliminated the charge for multimodal integration, established a fare equivalent to the one before the inauguration, increased the number of transfers trips from three

to four, increased the time of integration between the first and the last part of the commute from 70 to 120 minutes and allowed free tickets during the first week of operation. Despite facilitating the introduction of the new system, these changes helped to reduce fare revenue. In addition, there were cases of passengers who could not use the system due to its crowdedness, or recharge the card due to lack of recharge points. Others, simply irritated by the system, decided to evade the fare. All of this contributed to an average operating deficit of around US$ 500 million/year in the first years of operation (HIDALGO et al., 2016). Since this was not a planned deficit, it arose the need for subsidies. Later, this situation would raise demands from other cities in the country that also requested financial assistance for their systems.

The lack of bus-dedicated infrastructure had a severe impact in operational speeds, as the buses shared streets with other vehicles. Dwell times also increased due to a rise in the number of boardings — caused, among other factors, by the division of the city in the 10 different areas, which allowed only radial displacements. Hence, the few buses in operation took even longer to complete their routes, reducing the frequency and capacity of the system.

Only after launch the authorities did realized that increasing the operational speed was crucial to the success of Transantiago. Some dedicated lanes were quickly implemented to improve performance, however they were poorly supervised. A pre-payment system (called *corralitos*), installed in 30 stations with the highest demand, helped to increase operational speed, as customers could board through all doors. This helped to reduce fare evasion.

Although the system was not able to operate using information from GPS yet, the previous monitoring system (by agents prior to Transantiago launch) was


Santiago


Santiago

also abolished. With reduced reliability, customers chose, when possible, to use the metro, doubling the demand and rendering the system unable to absorb this increase, especially during peak hours.

The high occupancy of the metro, lack of transport service in some areas of the city and precarious conditions during the start of operation led to great protests by frustrated customers in the face of the failures of the new system. The government advertisement campaigns reinforced this feeling, once they promoted Transantiago as the main driver of improvement to public transport in the city. However, public transport became a major concern to the Chilean government. The constant negative presence in the media led politicians to lavish severe criticism of the system, a stark contrast to the low interest previously shown by politicians and the public opinion. There was panic among the authorities responsible for the system, and the opposition parties saw a great opportunity. Difficulties with Transantiago translated into negative impact on government approval rates (a decrease of around 30%), showing, however, that there was a high popular expectation with the new system. The service level was adjusted a year later, after replacements of authorities within Ministry of Transport and Transantiago, and adjustments in the bidding contracts that used to be most damaging to the public agency.

1.1.1 LESSONS LEARNED

- **Raising too high expectations and conveying generic information can frustrate customers.** In the case of Transantiago, authorities offered a vision difficult to achieve regarding what the new transport service would look like. Despite a high investment in marketing, the advertisement provided only generic information about the system, not instructing on the practical changes that it would lead (ZUROB et al., 2016). Soon after the operation started, satisfaction rates were below 10%, as shown in Figure 2.

- **Citizen participation is important.** Authorities decided not to publish details about the system before it was ready. As a result, the population was not prepared for the changes. In addition, new routes completely ignored the routes previously in operation.

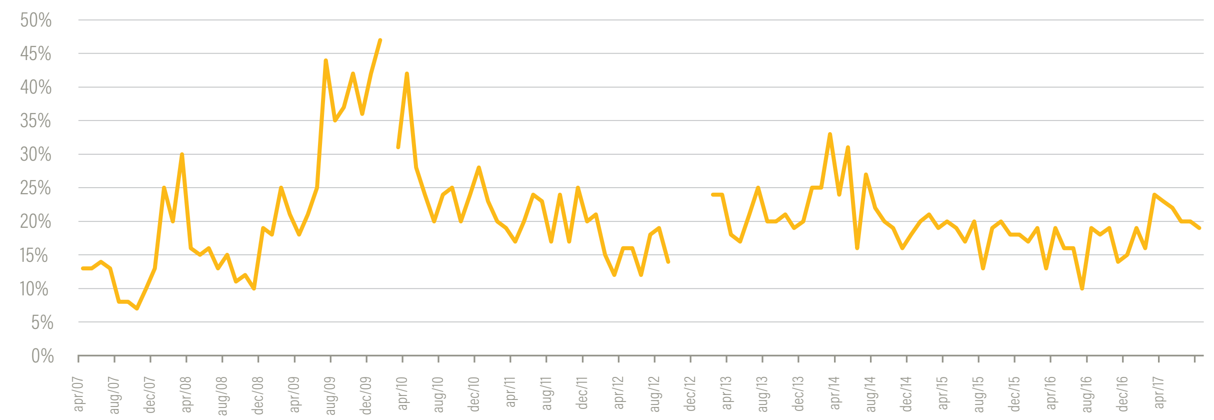
- **Transantiago had a limited legal and financial support.** A metropolitan transport authority was not established. Thus, even the most trivial adjustments required the consensus of different actors: ministers, municipalities, environmental entities. In addition, the legal framework that supported the system was very fragile. The group that managed Transantiago at the Ministry of Transport and Communications was also set up with very limited human resources.

- **The system lacked an adequate infrastructure.** The lack of dedicated -bus lanes resulted in operational speeds below the projected. Thus, the sizing of the fleet proved to be far below what was necessary. The social benefits of infrastructure should make it a priority of investment in transport.

- **Changes in the planning process may have negative consequences.** Authorities may wish to make some last-minute changes in key components of the system, ranging from operational to contractual or infrastructure issues. This must be considered with extreme attention, since a BRT is a complex system with many interacting components. Thus, changing something may result in negative effects, such as unplanned queues and financial deficits.

- **The implementation of the entire new system at once was a risky and costly choice.** It would have been better to phase it in, coordinating it with the launching of the new ticketing and payment system.

Figure 2 | **Variation in Transantiago approval rating over the years.**



Source: adapted from ADIMARK GFK, 2010, 2014, 2017.

- **The business model showed considerable problems.** Setting the right incentives through a contract with a public transport provider is not a simple task, as it requires a balanced operation between opposing forces. For example, while it is important to encourage frequent services, it is also necessary to control operational costs and their externalities which may require reducing frequency. Transantiago had to renegotiate its contracts several times during its more than ten years of operation.

Santiago

Bogotá

1.2
TRANSMILENIO PHASE II

TransMilenio is the BRT system of Bogotá (Colombia), a metropolis with 7.9 million inhabitants (WORLD RESOURCES INSTITUTE MÉXICO, 2017). The system has 112 km of bus-dedicated lanes and carries more than 2.4 million passengers per day (TRANSMILENIO, 2016; BRT+ CENTRE OF EXCELLENCE; EMBARQ, 2017). Its first phase started on December 18, 2000. At the end of December 2003, the Phase II began, being completed in April 2006 (HIDALGO et al., 2013).

In the final of Phase II, 13 stations were added to the 61 already in operation, and 84 trunk routes were identified, most of which were completely new to customers. The estimate was that, at the end of this phase, the system would have a demand of 1.4 million passengers per day, implying a substantial change in its operation, since the demand would practically double. There were changes in the bus lines, in the itineraries of 787 buses, in the routine of more than 4,000 drivers and in the way passengers used the system.

For just over a year, there was a study to analyze the origin-destination matrix of the system in order to offer a good service according to customers' needs. An additional bus fleet was planned and a specialist was hired to design informative maps that could communicate the changes in a clear way, informing about the new service alternatives, which should be faster and more efficient.

There was, however, a series of independent issue between the planning and operation plans of Phase II that summed up to a poor experience at day one: the new fleet was not fully incorporated, it was not possible to change the information system at all stations, the drivers training was limited, and part of the fleet did not respond to the operational management system. Educational and customer information measures were also limited.

To aggravate the scenario, on the same day that Phase II extension would start there was a protest about other public transport services. Elsewhere there was a program to eliminate lines and remove the obsolete fleet belonging to small informal bus operators. The elimination of these services led to a much higher demand than expected.

While program managers thought to have support teams at the stations, the execution was highly improvised. Ambassadors who were supposed to help customers with new services barely understood the changes themselves. Some did not even have training. It was difficult to maintain good information too, because over the next few weeks the services went through many changes, causing misinformation among trained teams.

Daily and non-habitual customers stopped commuting with the system as they feared getting lost in the new lines of TransMilenio, and were not able to find their way through the new information panels. There was great confusion regarding the use of the system, which led to protests that blocked the dedicated lanes to TransMilenio. The customer satisfaction rate fell by more than 20%. There was a need to request an additional fleet to

Bogotá

other Colombian BRT systems from smaller cities. This meant that constant restructuring of services, itineraries and route information were required (NO ..., 2006; ROJAS, 2006).

1.2.1 LIÇÕES APRENDIDAS

Usually, it is considered that only the launch of an entire new system's operation has challenges and that, from then on, everyone involved has enough knowledge about it. However, several lessons were learned from Phase II of TransMilenio.

- **Every single start of operation has challenges**. The preparation for a new phase of operation is as important as the initial one.
- **It is common for minor issues to happen in the first days of a new phase of operation.** Improving the system performance requires a longer time horizon both for the adaptation of customers to the new scheme and for minor adjustments by agencies. Recommendations include a previous preparation not only for the day one, but of constant monitoring during the first months of operation. Whenever possible, it is important to implement a new operation in several stages to provide customers with greater support.
- **It is a huge impact for everyone involved.** Local and national governments, private operators, customers, residents and media channels — it is necessary to identify, motivate and coordinate all actors involved so that all the fundamental actions for the operation are executed.
- **The biggest challenge is to reduce the negative impact and evoke a positive perception, showing people the benefits of the new system.** Only positive advertisements are not enough. It is essential to present information in a clear way and to instruct customers about the optimized use of the system. This reduces the initial negative impact that big changes usually raise.

- **Defining the first day is essential.** The start of operations cannot coincide with a day when customers are in a hurry and unwilling to learn. Therefore, periods of low demand such as Saturdays are a good option. This way, it is possible to make any necessary changes even on Sunday. It is preferable to start the operation in low season, vacation time or long holidays.
- **It is important to avoid other major or moderate transport changes that coincide with the inauguration of the system.** In the case of Bogotá, executing a program that would eliminate routes elsewhere while also removing the capacity in an obsolete fleet belonging to informal bus operators was not concluded in time before the opening of Phase II of TransMilenio. This confluence of factors led to chaos for some users and protests that could have been avoided.

Bogotá

Dar es Salaam

1.3 MAIN FINDINGS

Day One of Operation is critical to build a positive image of the system. Therefore, it is necessary to make every effort to ensure that everything is properly working. Despite political pressures to accelerate the process of implementation, usually when close to elections, it is necessary to evaluate the inauguration very carefully. It can be less costly to the system's image, to customers and even to public authorities to postpone the start of operation than to start without some of the functional elements.

Another recurring problem is a planning process centered only in infrastructure components and in the availability of fleet and technological systems for the start of operation. Planning how information will be made available to customers and to provide training for drivers and other personnel involved (support staff, ticketing staff) is just as important.

Engagement of city leaders in the design, planning and implementation of the bus systems is vital to its success. Strong leadership is essential to manage technical, economic, commercial, organizational and political risks, as there are several public and private entities involved in the process. This leadership will be the link to establish an effective communication between private entities and the public sector, which tend to work independently. The creation of a unit to manage the bus system during its planning, implementation and operation allows decision makers to delegate responsibilities, as there are several work fronts involved in the implementation of the system, including other instances in the city. This management unit must be supported by a solid institutional arrangement that guarantees its smooth functioning. In addition, it must be able to dialogue at the same level with city leaders and other actors involved in the project.

The existence of such unit also allows quicker responses to any problems that may arise and, at the same time, to the need for changes in the operation, since all information management will be under its responsibility.

In addition to city leaders, citizen participation is essential. Understanding people's desires and needs — such as creating new routes or extinguishing existing ones — enables better engagement and facilitate the communication and comprehension of the ongoing changes.

The development of the operation manual and contingency procedures supports this process to ensure that the implementation take place in line. The next chapter presents an objective and systematic guide to the elaboration of these materials.

Belo Horizonte

CHAPTER 2

GUIDE TO DEVELOP AN OPERATION MANUAL

Operational manuals and contingency procedures need to be prepare in advance of the beginning of the system.

The manual must contain all tasks and information necessary for good operation. The procedures, included in the manual, will guide the response in the event of any incident, ensuring that the operation is reestablished in a quick, effective, safe and standardized way. Internally, it is necessary to define in detail the role of each one involved in the planning, implementation and operation of the transport system, as well as allocate technical and financial resources. The development of the manual should occur before the inauguration or expansion phase, at least six months in advance. Systems already in operation can also use this guide to build-out and communicate operational procedures.

The existence of operation manuals is a common practice in many industries. Large companies, for example, use them to guarantee the correct execution of the most diverse operational procedures and, thus, to ensure quality of service. In the transport sector, it should not be different. Although some categories have already made great progress, such as logistics and rail transport, in the bus-based public transport the practice is still developing.

Belo Horizonte

Several elements require special attention, since it is essential that they are planned together and before the inauguration, so that Day One can occur successfully. Making a roadmap is a way to arrange all these items. It must be established by the entity responsible for the implementation of the system, setting a date for the start of operation.

This guide presents 20 essential elements that can be in the operation manual of the system, as displayed in Figure 3. This chapter describes each element and the Attachment 1 presents a summarized version of the elements.

Figure 3 | **Chapters of the operational manual**

Source: developed by the authors.

2.1
MANAGEMENT AUTHORITY AND GENERAL REGULATIONS

This section describes the competences and responsibilities of the entities related to the transport system. It must also specify aspects related to supervision and regulation.

2.1.1 TRANSPORT SYSTEM MANAGEMENT AUTHORITY

Define the competences of all entities related to the regulation and supervision of the transport system, their organizational structures and the functions of each level in the organization chart.

2.1.2 SERVICE SUPERVISION AND CONTROL MECHANISMS

Comprehensively describe the procedures for supervising data collection, information and monitoring, correction methods and sanctions applicable to each event.

2.1.3 OPERATIONAL CONTRACTS, LAWS AND APPLICABLE REGULATIONS

Indicate federal, state and city-level regulations related to public transport systems, mentioning each article, paragraph and proposed item. Service provision contracts must comply with current laws and regulations.

Belo Horizonte

2.2
MANUAL'S PURPOSE

The purpose of an operational manual relates to the following:

- determine a set of processes and procedures that, when applied, ensure a regular, reliable, safe and high-quality service to the customers of the bus system;
- provide clear and objective information to agents involved in the operation of the system; and
- establish parameters, roles, and actors responsible for decision-making.

A well-prepared operation manual is a guide for the implementation and operation of a robust transport system. It sets the basis for the Quality Management System of the management authority and the bus operator company, and can be easily formatted to meet documentary requirements of ISO Standards, what makes the company eligible for certifications and able to perform other levels of business management benchmarking within the market.

The manual must be aligned with operational regulations established by the government. It is important to include in the attachments any relevant regulations in force, so they can be used in trainings, in the creation of parameters for management and information systems, and in the development of procedures.

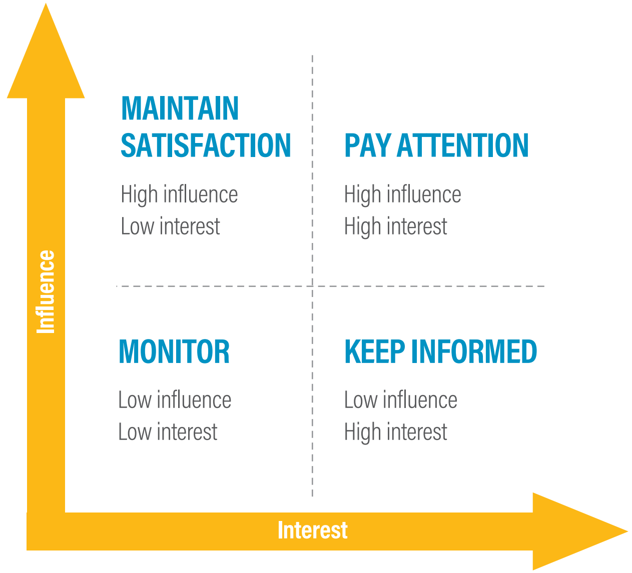
2.3
MANUAL'S SCOPE

To define the scope of the operation manual, it is necessary to map all stakeholders. This analysis identifies the actors' interests, expectations and influence, and determines their relationship with the purpose of the project. It also helps to identify relationships that can lead to potential alliances and partnerships in order to increase the project's probability of success (PROJECT MANAGEMENT INSTITUTE, 2013).

The mapping requires a list with all the actors involved in the operation of the new transport system. They must be categorized according to interest and influence, grouping stakeholders based on their level of authority (influence) and concern (interest) regarding the project's results (PROJECT MANAGEMENT INSTITUTE, 2013). With this classification, it is possible to design a map, as shown in Figure 4. Then, specific action plans for each quadrant must be drawn up.

Actions include inviting to periodic meetings about the status of the manual, informing about contingency procedures already created and asking for review, engaging all groups involved and, mainly, defining the level of information that each of them must receive (MULCAHY, 2013). This kind of map can be drawn up for other stages of the planning as well.

Figure 4 | **Stakeholders mapping**



Source: adapted from PROJECT MANAGEMENT INSTITUTE, 2013.

As an example, a mapping of actors can include the following groups:

- staff of management authority responsible for operation;
- staff of management authority responsible for inspection;
- staff of management authority responsible for planning;
- staff of other municipal departments and secretariats related to the transport system;
- staff of bus operator companies;
- staff allocated at the Operational Control Center;
- staff of the bus system ticketing service company(ies);
- technology provider of the bus system;
- surveillance staff;
- cleaning staff;
- firefighting staff;
- medical rescue staff;
- security staff.

It is also important that other actors — such as operation managers from operator companies of other transport modes, municipal guard and police service — are aware of the content in the operation manual. This content is a guide for the implementation and operation of the transport system, and must be continuously consulted and improved through the knowledge that acquires or changes over time. These updates must always be available to interest groups, so that everyone is aware of the latest version of the manual.

São Paulo

2.4
RESPONSIBILITY

The names of people responsible for developing, updating and approving the operation manual of the bus system must be listed here.

It is important that those responsible for the development of the guide have extensive operational knowledge about the transport system, to ensure that all necessary aspects are considered. A timeline for periodic review of the manual can also be defined in this section.

Ideally, the manual must be developed, periodically reviewed and approved by a committee including representatives from the bus operator company, the transit agency, and, if necessary, from a transport consultant company, and from other interested parties. The goal is to strengthen the content and identify opportunities for improvement on a continuous basis. Setting up a technical committee with an annual agenda is a common practice in the creation of national and international technical norms. In addition, the participation of people responsible for the operation of public transport systems in other cities can be extremely valuable as it increases the exchange of experiences and creates greater incentives for the practice of benchmarking (WORLD RESOURCES INSTITUTE BRASIL, 2018b).


Brasília

2.5 DEFINITIONS

This item must present a set of basic definitions so that anyone who joins the operation of the transport system (driver, supervisor, maintenance technician etc.) can understand the document. Definitions must be short, clear and precise. Some definitions that can be in this section are the following:

- Operational Control Center (OCC);
- BRT corridor;
- bus corridor;
- bus lanes;
- ticketing system;
- bus operator companies;
- bus management authority;
- bus stops/stations;
- integration terminals;
- transfer stations;
- express routes;
- conventional routes;
- feeder routes;
- maintenance area;
- parking area;
- fleet management software;
- route planning software;
- acronyms.

Dar es Salaam

2.6
SYSTEM'S OBJECTIVES

It is helpful to define a series of general objectives of the bus-priority system so that everyone involved in the operation is aware and can work to achieve them in the course of their activities. The list must answer the question: "What does this public transport system stand for?" Some objectives of the system can be (EMBARQ, 2013):

- offer the population an efficient, safe, fast, accessible for all, equitable and high-quality transport system, complementary to other modes and that allows customers to access the urban opportunities and make better use of their leisure time;

- contribute to the reduction of local pollutants and greenhouse gases emissions, rationally using a fleet of high technological standards, in a medium and high-capacity transport system that meets the needs of citizens (COOPER et al., 2012);

- increase public transport share in the municipal modal split;

- increase road safety and encourage physical activity (EMBARQ, 2015);

- meet the requirements of the National Urban Mobility Policy, reducing the dependence on individual motorized modes and promoting an integrated and multimodal transport network (BRASIL, 2012).

Curitiba

2.7
SYSTEM'S INFRASTRUCTURE

The manual must provide information about the system's infrastructure. If the system is under construction, it is essential that everyone involved has the latest version of the project and is aware of any adjustments — especially when there are different contractors executing the work, as in case of Box 1. In addition, the infrastructure must consider the type of vehicle that the system will use, both for initial and future demand, what may require vehicles of different dimensions (ASSOCIAÇÃO NACIONAL DE FABRICANTES DOS ÔNIBUS, 2011; BRASIL, 2017; INSTITUTE FOR TRANSPORTATION AND DEVELOPMENT POLICY, 2017).

2.7.1 DEDICATED BUS LANES

A bus-priority system can have bus-dedicated lanes, which can be categorized as:

- BRT corridor;
- bus corridor (located in the center of the road, but which does not qualify as BRT);
- bus lane (at the curbside).

2.7.1.1 BRT CORRIDOR/BUS CORRIDOR/"NAME X" BUS LANE

This item, as well as its sub-items, must be replicated so that each of the system's dedicated lanes is covered here.

A) GENERAL FEATURES

This item must present the description of the lane category, operation times and definition of whether the lane will be exclusive for buses or there will be exceptions, such as for emergency vehicles or cash transportation. It must also specify the lane's length, type of pavement and number of stations and integration terminals, highlighting where customers can access other bus-priority routes or other modes of transport — subway, Light Rail Vehicle, cable car, bike sharing system etc.

In addition, this section must include information such as lane width, direction of circulation and points for detours in case of contingencies. If there are underground ducts adjacent to the track, it is important to point their position and the type of cabling in the duct (optical fiber, data cables, control traffic and safety equipment, ticket sales and fleet monitoring)

B) ROUTES

This item must present a codified list of the routes in the system, specifying:

- length;
- itinerary, with a route diagram of each line that run through the bus-dedicated lane;
- journey start and end times and headway for each route that operate on the bus-dedicated lane;
- terminals/stations/bus stops that the route will serve;
- types of vehicles used in each route;
- number of vehicles to meet the demand.
- If the system has a trunk-feeder operation — common in BRT systems — it is indicated that the information is detailed for both trunk-feeder routes.

If the system has a trunk-feeder operation — common in BRT systems — it is indicated that the information is detailed for both trunk-feeder routes.

2.7.2 INTEGRATION TERMINALS

Integration terminals must be physically described, informing:

- full capacity estimation of the infrastructure;
- the layout of the terminal, including the number of vehicles docking bays and the stop position of each route, height of the boarding platform, accesses, emergency exits, places for parking vehicles between peak times etc.

In both terminals and stations, the location of services in the bays must be carefully designed. If poorly planned, it can lead to bus queues and agglomerations of passengers getting on and off the bus, what directly affect the operation and the perception of the quality of service.

It is also necessary to describe the operability of the terminal, start and end points of the routes, studies of time spent and movements of passengers getting on and off the buses in the platforms, the way of organizing the flow of people and other operational particularities of the terminal.

If any, returns between on and of boarding areas must also be indicated.

2.7.3 TRANSFER STATIONS

Transfer stations must be located in places that allow access to other bus-dedicated lanes or transport modes. All physical and operational features of the vehicles that will use the facilities need to be described and considered, in order to enable all the necessary maneuvers. If necessary, this item can specify the location of internal stops, the dimensions of the station (including the height of the boarding platform), directions of circulation, the width of the lanes and the turning radii. The maximum capacity of operation and a brief description of estimated times of maneuvers on the boarding platforms can be included.

Belo Horizonte

2.7.4 STANDARD STATIONS

In this section, it is important to describe the location and typology of the stations (closed stations, bus stops, number of modules), along with the number of docking positions in each station, its maximum capacity and the vehicles that can use it (standard, articulated, bi-articulated etc.).

2.7.5 GARAGES

This section must include the following topics, relevant to a good operation of the garages:

- isolation area, security and control of parking, maneuvering and cleaning areas, in order to avoid conflict among vehicles and people and reduce the risk of accidents;

- fire safety management procedures, firefighting system, atmospheric discharges protection system;

- environment management procedures, especially related to leak containment, fuel oil and lubricants storage, washing water reuse, liquid and solid waste disposal, spare parts discard, in accordance with relevant environmental regulations;

- rest and gathering area for drivers, mechanics and other employees or outsourced staff, including canteens, restrooms and changing rooms, in accordance with the relevant work safety regulatory norms.

2.7.5.1 PARKING AREAS

A description of the location and size of the fleet's parking areas must be in the manual. There must be enough space to park all vehicles and it is convenient to build these areas in places with access to or within integration terminals, in order to avoid additional costs with trips without passengers. It is important to define the layout of the parking, including the width of the road boxes and internal directions of circulation, in addition to elaborating entry and exit procedures. These procedures facilitate the maneuverings without harming the operation of the system. The planning process must be in accordance with response times in case of contingencies, in order to standardize the use of the facilities by the vehicles.

Bogotá

2.7.5.2 TECHNICAL SUPPORT AREAS

The manual must describe the technical support areas (maintenance, washing, fuel supply etc.) and establish a set of rules for their operation. It is also necessary to point one or more appropriate places for mechanical maintenance and cleaning, aiming to ensure an excellent service and a good image for the system. It is imperative to guarantee the physical capacity of the support area to admit simultaneous maintenances, considering cleaning and mechanical maintenance between operation hours of each vehicle. The same way as in the parking area, the planning of the technical support area must be in accordance with response times in case of contingencies, in order to standardize the use of the facilities by the vehicles.

2.7.6 SIGNAGE

This item must include a detailed list of vertical, horizontal and traffic light signs for both public streets and the system's internal facilities. The list must specify type, use and quantity of different kinds of signs. It is recommended to include the signage projects in the attachments of the operation manual.

2.7.7 OPERATIONAL CONTROL CENTER

If the system has a control center, this item needs to present:

- architectural project features;
- details of logical and communications infrastructure, considering communication with fleet, road, stations, garages and the electronic ticketing processing center;
- layout of the operational room, including staff allocation (managers, supervisors, traffic controllers, emergency staff, property security, public security, firefighting staff, medical rescue staff, station support staff, maintenance and engineering, information technology, communications, press office, customer service etc.).

Medellín

Box 1 | MOVE - BELO HORIZONTE

Acknowledging the importance of the Day One of Operation, Belo Horizonte's Transport and Transit Agency (BHTRANS, in the Portuguese acronym) and WRI Brasil carried out a specific work to minimize the risks in the beginning of the operation of MOVE, the city's BRT system.

This work started five months before the system's inauguration, with the gathering of a technical team composed of professionals who had already experienced a structural change in public transport in other cities. There were (i) meetings with the different actors involved in the implementation of MOVE, (ii) visits to civic works, and (iii) training workshop with key stakeholders.

Internal actors of the City Hall (including representatives from transport, civic works and information agencies) and external actors (municipal and metropolitan bus operators and ticketing companies) were heard separately to understand their expectations and concerns. Although each actor is responsible for a specific component of the system, all of them are essential and need to be aligned for a successful launching.

The main results of these meetings included the acknowledgement, by the actors involved, of the importance of conducting trainings regarding activities that were not usual in the conventional transport system — such as docking at stations — and the decision to implement the system in three phases, in order to minimize the impact of the changes.

On-site visits (to corridors, stations and terminals) provided a better understanding of the system. Specifically in Belo Horizonte, these visits were key to identifying possible problems in the interfaces among the civic works, since the infrastructure was divided into several segments in the city's bidding process. The visits helped to identify and solve a point of concern: in an intersection that connected one of MOVE's corridors to one of the terminals, the responsible for each work had a different version of the project for the same location.

In order to warn about possible difficulties, the training workshop presented challenges faced by other Latin American cities before the inauguration of their systems. There were debates and simulations of possible situations of application of operational procedures and contingency plans. Such processes aim to qualify the service and standardize the decision-making in face of different incidents in the system. One of the simulated situations was the occurrence of a swarm of bees at a transfer station: an unusual event that coincidentally happened only three months after the opening of MOVE. The simulation allowed the different parts involved to be prepared to act quickly and efficiently to solve the contingency. Knowing in advance the appropriate response, who is responsible for each step and when to trigger each activity, is critical to solve incidents and to minimize negative impacts on the system.

Belo Horizonte

2.8
SYSTEM'S FLEET

A description of the fleet operating in the system (standard, articulated and bi-articulated, if applicable) needs to be in this section. If the system has a trunk-feeder operation —common in BRT systems — it is suggested that the information is detailed for both trunk and feeder routes (INSTITUTE FOR TRANSPORTATION AND DEVELOPMENT POLICY, 2017).

2.8.1 GENERAL FEATURES

This item must present a summary sheet with the features of vehicles that will operate in the system. The sheet must contain dimensions, weight, capacity, materials, turning radii, number and position of the doors, chassis height, engine power, fuel, emission levels, among others. If applicable, the features can be compared with municipal technical standards to check if they comply with the requirements.

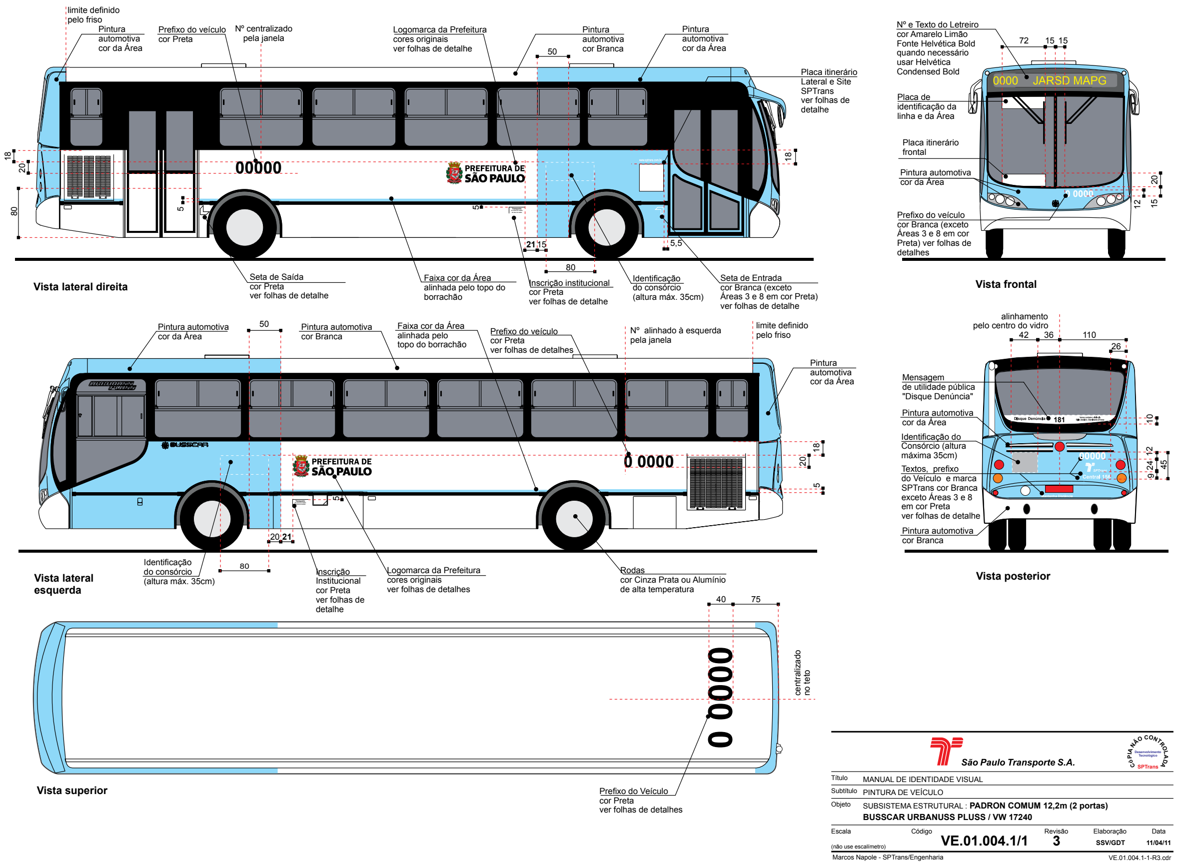
2.8.2 VEHICLES VISUAL IDENTITY

This item must detail the visual identity of vehicles. It is important to present the dimensions of paintings, stickers and signs, type of font and colors (by PANTONE code) so that they can be easily found in the future. Exact specifications of scale and location of logos or any art defined by the regulator entity also need to be informed so that all vehicles have the same layout (EMBARQ, 2011).

It is recommended to use diagrams with scale drawings of the front, sides, rear and roof of the vehicles, placing the images in sequence and comparing their features (Figure 5). These diagrams must be in accordance with different vehicle models and services (for example, trunk and feeder, operating areas etc.).

São Paulo's Transport Agency (2011) has a good example of visual identity manual. The guide lists all the basic features of diagramming and implementation of internal and external visual communication of the vehicles. Due to the large amount of information and details, these items can be in a specific visual identity manual for the system.

Figure 5 | **Example of vehicle diagrams**



Source: provided by SÃO PAULO TRANSPORTE S.A.

2.8.3 VEHICLES ENVIRONMENTAL PERFORMANCE

Regarding environmental performance, it is necessary to present the maximum permitted levels of pollutants (NOx, SOx, HCN) and particulate matter, as well as noise emissions, based on appropriate municipal and international standards. It is necessary to establish periodic reviews to measure emissions and propose action plans in case of exceeding the established limits. The Sulphur content of the fuel also must be reported (INSTITUTO BRASIL DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS, 2016).

2.9 OPERATION

This item must describe the main operational parameters of the public transport system. Examples of these parameters are in the following sub-items.

2.9.1 SPEED LIMIT

Indicate the maximum speed limit allowed by the system in bus lanes and mixed traffic lanes, as well as when approaching and leaving stations and bus stops (INSTITUTE FOR TRANSPORTATION AND DEVELOPMENT POLICY, 2017).

2.9.2 OPERATION TIMES IN STANDARD STATIONS AND BUS STOPS

Define the times of entry, docking, boarding, and exit maneuvers in standard stations and bus stops, in order to guarantee the frequency times between stations and to standardize the operation. In BRT systems, it is recommended that each bay in the station operate with a maximum of 60 vehicles/hour (WRIGHT; HOOK, 2008).

2.9.3 OPERATION TIMES IN INTEGRATION TERMINALS

Establish maneuver times at integration terminals, disaggregating in entry maneuvers, docking at the platform, total on and off boarding, and exit maneuvers, in the same way as in stations.

2.9.4 APPROACHING AND EXIT MANEUVERS

Define the signaling of approaching and exit maneuvers in stations and terminals, in order to prevent conflicts between buses and a consequent decrease in the operational speed of the system. It is also necessary that the transition area offer enough space to avoid sudden maneuvers. If applicable, this item can also describe the docking system (TAVARES, 2015).

2.9.5 OPERATIONAL PLANS

Create operational plans for situations that require detours. The item must detail all actions, actors responsible and the frequency of application of these plans. Operational plans are applicable to routine activities of the system, while contingency procedures, detailed in item 2.17, represent possible incidents.

Some examples of activities that can be in this item are:

- street lightning maintenance that require using trucks;
- weeding and tree pruning;
- maintenance of pavement and underground elements that require excavating the pavement;
- maintenance of vertical and horizontal signs and traffic lights;
- procedure for maintenance of roads with partial or total closure of overpasses and tunnels.

Rio de Janeiro

Rio de Janeiro

2.10 DRIVERS

This item aims to describe rules, norms and procedures established for drivers. The following sub-items describe some of these guidelines.

2.10.1 APPLICABLE NORMS

According to BRASIL (1997), to drive a public transport vehicle, the candidate must meet the following requirements:

- be over 21 years old;
- be qualified in the category corresponding to the vehicle to be driven;
- not having committed any serious or very serious infractions or being a repeat offender for medium infractions during the last twelve months;
- approval in a specialized course and in a vehicular practice in risky situations training, under the terms included in Resolution number 168/04 and its subsequent amendments (BRASIL, 2004).

This item also needs to list other laws and norms that establish the minimum conditions necessary to be a bus transit driver, such as municipal regulations or internal norms of the bus operator company.

2.10.2 TRAINING PROGRAM

Detail what the training program consists of, describing training modules, course load, evaluation methods, minimum levels for approval and frequency in which the training must be repeated. It is recommended that the program contains at least the following modules:

- behavioral: instruction on attitudes and behaviors that assist the mediation of conflicts and help drivers to contribute to a positive image of the system, transporting customers with responsibility, comfort, receptivity, courtesy and sympathy;
- defensive driving: training drivers to avoid potential dangerous behaviors of other road users, anticipating risky situations, despite adverse conditions;

- driving practice: training drivers to be familiar with the vehicle's on-board system, so they will be able to drive according to the system's regulations. It is also essential to practice the approaching of the vehicle to station and bus stops (in closed stations, for example, the driver needs to align the vehicle doors with the station doors to allow boarding). This module must enhance the importance of driving practice to maintain the established headway between vehicles.

In addition to these, there are other relevant trainings, such as first aid. Chart 1 shows an indication of workload for a BRT drivers' training (it may vary depending on previous training programs). It is also necessary to define what will be the procedure when employees do not reach the minimum required score: repeat the program, extend its duration or exclude them from the system.

Performance evaluation modules, rewarding the best professionals and creating opportunities for professional growth in the organization, can also be included. EMBARQ Brasil (2014b) presents several information about acknowledgement programs.

Chart 1 | **Drivers training workload**

MODULE	WORKLOAD (HOURS)
Behavioral	4 to 14
Defensive driving	7 to 27
Driving practice	6 to 22
Operation and contingency procedures	8 to 22

Source: based on EMPRESA DE TRANSPORTES TRÂNSITO DE BELO HORIZONTE, 2013; TRANSMILENIO, 2012.

2.10.3 MEDICAL EXAMS

2.10.3.1 PHYSICAL EXAMS

Describe necessary procedures and regularity of exams that drivers and aspiring drivers need to do. The maximum interval between exams can be based on current local regulations of traffic and transport.

2.10.3.2 PSYCHOLOGICAL EXAMS

Describe necessary procedures and regularity of exams that drivers and aspiring drivers need to do. The maximum interval between exams can be based on current local regulations of traffic and transport. It is also necessary to specify help and reinsertion mechanisms for drivers who, for any reason, require a psychological treatment due to the work activities.

2.10.4 DRIVING EVALUATION

Evaluate the driver's performance in a test track with controlled conditions. It should allow the assessment of the driver's expertise according to the type of vehicle, under pressure conditions and with difficult maneuvers that simulate real situations. It is necessary to define the duration of the test, aspects to be evaluated, the length of the track and frequency, if necessary.

2.10.5 DOCUMENTS REQUIRED TO EMPLOYMENT

List of the required documents to employ aspiring drivers, which must be in accordance with transport laws and regulations and not violate the rights of the worker.

Examples of commonly required documents are:

- driver's license (according to the type of vehicle);
- occupational health certificate;
- psychological certificate;
- certificate of criminal record;
- educational title (regarding the level required by the operator company);
- national, regional or municipal legal forms necessary to employment;
- documents that, within the laws, regulations, rules and contracts, are necessary for the employment bond.

2.10.6 DUTIES AND OBLIGATIONS

Establish a set of duties and obligations and make it available for drivers starting when they express intention to work in the system. Likewise, it is important to define supervision and control mechanisms and disciplinary measures for each type of fault, in addition to incentives for training and good performance of employees.


Belo Horizonte

2.11 ROUTE PLANNING SYSTEM

This item covers general aspects regarding the planning of the routes of the transport system. The following sub-items describe some suggested topics.

2.11.1 OPERATIONAL INFORMATION

2.11.1.1 DEMAND PROJECTION

Include demand projection of the routes in the origin-destination survey.

2.11.1.2 TICKETING SYSTEM INFORMATION

Define the ticketing system reports that will be used in the route planning, as well as their interval of analysis (every hour, every 15 minutes). Likewise, it is necessary to identify the information to be reported; for example, number of passages through the turnstile by direction (entry/exit).

2.11.1.3 FLEET MANAGEMENT SYSTEM INFORMATION

Define the reports of the fleet management system that will be the base of the route planning. Set fleet groups (for each route), interval of information analysis (hourly, every 15 minutes) and delivery of reports (daily, weekly or monthly). It is necessary to identify the information to be reported; for example, service time records between check points, roundtrip time records, record of regularity and punctuality indicators etc.

2.11.1.4 FIELD STUDY INFORMATION

Make a list of field studies and their interval, as well as the information they need to collect, so it is possible to recalibrate the system according to needs that emerge over time. Some parameters that can be collected are:

- ridership;
- vehicle occupation;
- number of transfers.

This information can based on frequency adjustments, fleet redistribution among routes and updates in the origin-destination matrix.

2.11.2 PROJECT PARAMETERS FOR ROUTE PLANNING

2.11.2.1 VEHICLE CAPACITY

For each line, it is necessary to specify the type of vehicle, its dimensions and capacity (sitting passengers and total passengers). To ensure comfort and easy circulation inside the vehicle, a good measure is of 3 standing passengers per square meter, with a maximum of 5 passengers per square meter (VUCHIC, 2007). The use of a lower value aims to provide comfort – a key component for the customer satisfaction and a positive image of the system.

2.11.2.2 SERVICE TIMES

Specify times for boarding maneuvers and estimated travel times for all lines.

2.11.2.3 MINIMUM AND MAXIMUM HEADWAY BETWEEN VEHICLES

Determine the headway between vehicles of each route, necessarily considering the demand of the most crowded section of the line and the vehicle capacity. This will be the minimum headway allowed and it will be adjusted according to the tolerance established by the system operator to set the intervals.

As a reference, in BRT systems operating in peak times, the routes can have headways ranging from 2 to 6 minutes (frequency from 10 to 30 vehicles per hour). However, systems like TransMilenio can have headways of 1 minute in a single route. If the necessary headway in the same route is less than 2 minutes, this route may be sectioned in two services.

At the same time, if the headway is longer than 6 minutes, then it is possible to consider the merging of two routes (WRIGHT; HOOK, 2008; INSTITUTE FOR TRANSPORTATION AND DEVELOPMENT POLICY, 2017).

Headways between vehicles out of peak times are longer due to the lower demand of passengers. However, if the intervals out of peak times are excessively longs, it impairs the viability of the system.

In BRT systems, the recommendation is of maximum headways of 10 minutes out of peak times (WRIGHT; HOOK, 2008). Nevertheless, it is important that the headway is established according to technical issues of the system.

2.11.2.4 BUS STOPS, STATIONS AND TERMINALS CAPACITY

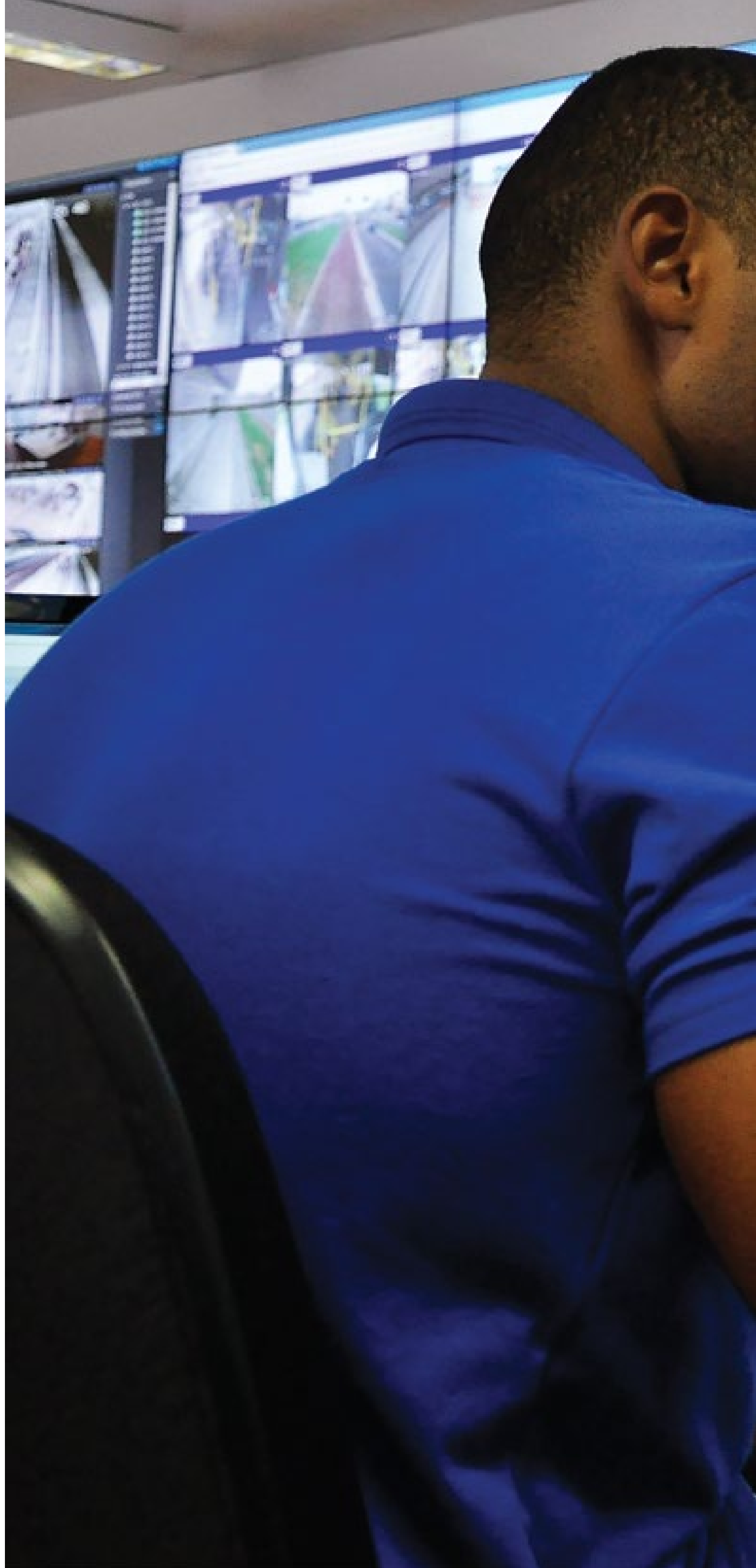
Terminals, stations and bus stops need enough capacity to accommodate the demand of the routes they serve. It is important to consider that capacity depends on geometry, length, number of service platforms etc. If the capacity is not properly measured, there will be queues. It is necessary to build a table reporting the maximum capacity of each station to serve as input for the system's operational programming decisions.

2.11.2.5 SPEED LIMITS

Establish appropriate speeds for each section of the bus-dedicated lane. This ensures an effective operation and helps to prevent road crashes. It is necessary that speed limits are appropriate to physical features of the road infrastructure and to the operational level. Especially inside terminals, close to stations and bus stops, speed limits must be lower due to the high flow of pedestrians and, therefore, a greater risk of road crashes.

2.11.3 ITINERARIES AND TIMETABLE

Provide a detailed description of the itinerary of each route since the exit from the garage, considering routes, estimated and maximum operation times. The timetable of the routes also must be in this item. If the system has a trunk-feeder operation — common in BRT systems — it is indicated to detail this information for both the trunk and feeder routes.



Rio de Janeiro

Rio de Janeiro

2.12
FLEET MANAGEMENT SYSTEM

An effective fleet management requires that both the management authority and the public transport operator are aware of the data. To do that, a municipal authority can apply regulations regarding information ownership and processing, ensuring access to the databases. A plausible solution may be the existence of mirror servers on the system, if private companies manage it.

2.12.1 FLEET CONTROL EQUIPMENT AND APPLICATIONS

Establish the hardware and software elements of the fleet management system. The item must describe equipment, programs, features, reports, performance levels and other aspects that compose the system.

It is important that the fleet management system is scalable, able to support a growth in demand and, consequently, in the fleet and the volume of data to be processed. The system also needs interoperability, so it can be integrated with complementary software such as the ones of route planning and customer information. In addition, it must be implemented following a system engineering approach to meet technical market standards and achieve a high level of quality and performance (DARIDO; PENA, 2012).

2.12.1.1 SOFTWARE

If used, specify the software, version, manufacturer and minimum installation requirements. It is also important to identify the existence of a user manual, periodic courses and updates for the team that will use the software. This item can also describe the minimum requirements necessary for fleet management so operators can choose the software that best meet their needs.

2.12.1.2 SYSTEM FEATURES

Describe the functionalities of the fleet management system. The following sub-items describe some of the functions.

A) BUS ITINERARY MONITORING

Explain the mechanism that will monitor the itineraries and ensure its fulfilment. This is necessary to check travel times and stops, according to the plan established for each direction of operation.

B) DRIVERS SHIFTS MONITORING

Describe how the monitoring and designation of drivers will be made, so everyone involved is aware of who is the driver of each route at any given time, in case of any incident or extraordinary event.

C) REPORTS

List and detail the reports generated by the system. This item can include:

- operational occurrences: using short communication codes, record the different operational news that occurred during each work shift. It is important to standardize the information to enable a later follow-up of the events during the shift of each employee;

- traveled distance by service and driver: the fleet management system must be able to generate reports of traveled distances in kilometers by service, driver and vehicle, in order to compare it with the schedule for each route;

- service time: define the parameters to evaluate during the service period. The report can include travel time by direction, roundtrip (total travel time in both directions), travel times between garage and terminal, and stop times at stations and terminals. This way it is possible to have a more accurate control of the operation.

D) REGULARITY AND PUNCTUALITY INDICATORS CALCULATION

Provide information that allows basic management indicators in real time by driver, vehicle and route, in order to respond in real time when necessary and to maintain the efficiency and reliability standards of the system. The indicators can include the trips fulfilment index (realized trips/scheduled trips) and the travel punctuality index (trips departing at the scheduled time/scheduled trips).

E) ESTIMATES OF ARRIVALS AT THE NEXT STATIONS

Describe how the system will calculate the estimates of arrival times of a route at the next station. This allows the system to inform customers about the remaining time until the arrival of the next vehicle.

F) DELAYS AND POSTPONEMENTS

Describe the functionality that will indicate delays and postponements to both drivers and technicians at the operational control center. Such information is critical to regulate the operation. Based on this information, it is possible to establish parameters to apply sanctions for delays and postponements.

Rio de Janeiro

Rio de Janeiro

2.13
TICKETING SYSTEM

As in the fleet management system (item 2.12), the management authority must have full access to the information generated by the ticketing system (INSTITUTE FOR TRANSPORTATION AND DEVELOPMENT POLICY, 2017). The following sub-items describe the topics that this chapter of the operation manual can cover.

2.13.1 DEFINITION OF THE SYSTEM AND PARTICIPATING AGENTS

Describe the operation of the ticketing system (technology and intervening agents) as well as the destination of the revenue (distribution among shareholders or service operators and mechanisms and percentages of reinvestment in the system). It is also important to present the mechanisms for monitoring and auditing the system.

2.13.2 TICKETING SYSTEM EQUIPMENT AND APPLICATIONS

Make a list of all equipment and applications that the ticketing system will use. This item must include a description of the functionality of the most relevant equipment, such as access controls, access and recharge validators, and contingency and replacement equipment, as well as a brief description of the location, recommended supplier and estimated lifecycle of each equipment.

2.13.3 CENTRAL EQUIPMENT

Describe the functionality, location and backup system of the central equipment that store all the data coming from the ticketing system, specifying the auditing mechanisms.

2.13.4 EQUIPMENT IN STATIONS AND TERMINALS

Describe the equipment of the ticketing system used in stations and terminals to sell tickets or credits, validate tickets and control the access to boarding platforms.

2.13.5 SYSTEM FEATURES

2.13.5.1 TICKETING VALIDATION AND ACCESS REPORT

Describe the recording process of access and ticketing validation (in case of BRT systems, specify the process within the units of the feeder system and in the stations of the trunk routes). The item must also describe the data transmission to the ticketing operation center.

2.13.5.2 REPORTS

Define the reports that will present data regarding customers' travel patterns and information about the performance of the technological platform, with an emphasis on the veracity and integrity of the information. Table 2 proposes a list of reports; other reports can be added if relevant.

Chart 2 | **List of possible reports using ticketing data**

RECHARGE	OPERATION	INVENTORY LEVEL	MAINTENANCE
• Total • By recharge point • By group of recharge points • By time periods configurable by the transport authority • By distribution channel • By fare type • By card type • By fare type and payment method	• Validations, in configurable periods: - By terminal - By station - By route - By vehicle - By bus operator company - By card type - By fare type • Multimodal integration records • On and off boarding matrix per route (estimate)	• Number of new cards in customizable periods • Lost, stolen or damaged cards • Number of unread cards • Average time between the collection and the consignment of cash • Sold cards by sale point, by customizable time period	• Conditions of operation of equipment, communication channels and local networks at the ticketing operation center, stations and/or maintenance workshops • Equipment failure at the ticketing operation center, stations and/ or maintenance workshops • Statistics of equipment failure at the ticketing operation center, stations and/or maintenance workshops • List of equipment at maintenance workshops • Details of other equipment, such as encoders, payment method recorders, local networks etc. • Inventory of replacement equipment • Repair average time by type of equipment and by type of failure • Average time of attention/solution to problems during peak and off-peak hours • Average operating time by equipment

Source: developed by the authors.

2.13.5.3 STATISTICAL ANALYSIS

Define the statistical indicators to evaluate the ticketing system, such as waiting times in the purchase queues, access times, and availability of payment methods. It is necessary to establish sources of information and data collection mechanisms, as well as the collection interval, in order to evaluate the performance of the system.

2.13.5.4 SYSTEM FAILURES SOLUTION

Establish and describe protocols of observation and solution of problems, informing which human resources are necessary. It is also important to define the required time of attention and the contingency plans for the periods of testing and solving the problem.

2.13.5.5 RECORDS, CALCULATION AND MONITORING OF SERVICE LEVELS

Incorporate service indicators from statistical analysis to compare with the service levels previously established.

Belo Horizonte

Belo Horizonte

2.14 CUSTOMER INFORMATION SYSTEM

Customer information systems consist of all elements that help customers to understand how the transport system operates (EMBARQ, 2011). Public transport services with a good customer information system are more likely to attract passengers, especially those who do not use the service regularly.

TWO MAIN ELEMENTS CAN BE PART OF THE CUSTOMER INFORMATION SYSTEM:

- information system in online media, such as website, social network and smartphones applications;
- information system in terminals and stations, such as maps of the bus lines and surrounding area.

It is imperative to establish inspection, maintenance, updating and replacement procedures to the information system, in online media as well as in terminals and stations. This way, customers will be aware of any information, thereby decision-making within the system can be timely and agile.

In order to be easily replicable in the future, it is recommended that the colors of the system are registered (by PANTONE code), as well as the exact specifications of scale and location of logos or any graphic art defined by the regulator, so that all graphic materials have the same layout (EMBARQ, 2011).

Together with the visual identity of the vehicles, this item covers topics that deserve dedicated guidelines. If the system has a specific visual identity manual, it must be included here.

The following sub-items highlight some specific topics of the information system in stations and terminals.

2.14.1 STATIC CUSTOMER INFORMATION SYSTEM

2.14.1.1 SYSTEM MAP

Define location, dimensions and colors, already used in the transport system description, so it is easy to distinguish the different services or other modes of transport. It is important to insert the names of relevant streets on the map, so customers can easily identify where they are. A simplified version of the map (synoptic map, as shown in Figure 6) can also be on board of the vehicles and on the automatic doors of each station.

It is advisable to pay special attention to the position of the maps inside the stations. When there are two confronting maps (one facing the other), for example, both must indicate the same directions: that is, be mirrored. Because of this, more than one version for the same map are necessary. Finally, it is important that focus groups evaluate the maps to verify that the symbols are clear enough for people still unfamiliar with the system. Using standardized and easy-to-understand icons helps customers. Vertical, horizontal and 45° lines also promote a better understanding of the maps (BOOTH, 2012).

2.14.1.2 TERMINALS AND STATIONS MAP

Describe the location and dimensions of terminals and stations, indicating the boarding points of each routes, information and ticketing vendors, emergency exits signs and the direction of the vehicles in each side of the platform.

2.14.1.3 NEIGHBORHOOD MAP

Describe the area surrounding the terminal, station or bus stop (dimension, colors, scales etc.). The map must be drawn on a scale that makes it possible to see other nearby stops. In addition, it is necessary to indicate the directions and destinations of the routes that pass through the station, as well as relevant information about the surrounding area.

Figure 6 | **Synoptic map**

Source: adapted from SÃO PAULO, 2018.

2.14.2 DYNAMIC CUSTOMER INFORMATION SYSTEM

2.14.2.1 TECHNOLOGY

Describe the technology to transmit information to customers (operating routes, times and itineraries). It is necessary to indicate the responsible for updating the information panels.

2.14.2.2 NEXT ARRIVALS AND DEPARTURE INFORMATION

Describe the mechanism to inform arrivals and departures times in stations or terminals. It is also important to define the frequency of reviews for this functionality to ensure it is always working correctly.

2.14.2.3 EMERGENCY AND CONTINGENCY INFORMATION

Describe and categorize common emergencies and contingencies and the protocols for disclosing information from the Operational Control Center, as noted in section 2.17 (Contingency procedures).

2.14.2.4 PUBLIC UTILITY INFORMATION

Define what is a public utility information, who is authorized to disclose it, within which parameters it will be divulgated, what are the minimum and maximum durations of the information.

2.14.2.5 VARIABLE MESSAGE PANELS ON BOARD OF BUSES

Describe, by vehicle type, the number and location of the variable message panels on board of buses. It is also necessary to define the content of the information (system information, advertisements, news of public utility), as well as the mechanisms necessary to insert the information on the panels.

2.14.2.6 VARIABLE MESSAGE PANELS IN STATIONS AND TERMINALS

Make a description, by type of station, of the number and location of the variable message panels inside stations and terminals. It is also necessary to define the content of the information (system information, advertisements, news of public utility), as well as the mechanisms necessary to insert the information on the panels.

Rio de Janeiro

2.15
ROAD SAFETY

Road safety is a fundamental component within the transport system. In general, the operation of bus-priority systems represents a major contribution to reducing the frequency and severity of road crashes (EMBARQ, 2015). Despite this, accidents that occur in organized transport systems are more visible and noticeable to public opinion. It is important to consider relevant risk factors and actions to prevent road crashes and reduce their severity. In addition, clear policies must be established, such as indicators and targets that contribute to a safe operation. Assertive communication with those in charge of the operation is also essential, as well as a systematic and standardized record of the crashes, so this data can support preventive and risk mitigation actions.

2.15.1 DEFINITION OF A RISK MAP

Identify the most relevant risk factors, analyzing in detail the infrastructure elements of the system, for example:

- road design;
- dedicated lanes design;
- intersections design;
- accesses and exits from stations;
- integration points between trunk and feeder routes;
- bus docking points;
- waiting areas for passengers;
- circulation areas for vehicles and passengers.

In addition, it is important to do a continuous mapping of the informal crossing points most used by pedestrians, since they can indicate a necessary review of the location of pedestrian crossings or implementation of direction arrows or impedances. It is also necessary to analyze if elements such as signs (vertical, horizontal and traffic lights), lighting and design, among others, are adequate and contribute to maintain the system safe. An infrastructure inspection procedure needs to be defined to warn in case of any deterioration that puts the safety of customers or anyone potentially affected at risk. In the same way, it is necessary to establish safety inspections in the fleet that point damages in the vehicles.

2.15.2 DRIVING PRINCIPLES

2.15.2.1 SAFE MANEUVERS

Indicate desirable behaviors that contribute to improving road safety during the operation. The following list presents some examples, but it is necessary to review and complement it:

- driver position;
- driving posture;
- slight approach to boarding platforms (includes instructions regarding the speed limit around the stations);
- traffic signs to inform change of lane, approaching of a station or the use of priority at points of conflict;
- safe practices to avoid blocking traffic lights with pedestrians and cyclists' crossings.

2.15.2.2 PRIORITY OF VEHICLES IN OPERATION, INTERSECTIONS AND TERMINALS

Establish an order of priority for dedicated lanes, integration terminals and stations and make it explicit in the operation manual and through on-site signage. Inside the integration terminals and along the itineraries, different vehicular and pedestrian movements can be conflicting. The access, exit and return maneuvers of trunk and feeder vehicles, as well as their distribution among the different platforms in the stations, requires a definition of this priority order.

2.15.2.3 COMMUNICATION PROTOCOLS

Establish protocols that ensure an agile, effective and timely communications. It is necessary to include a short code of the most frequent situations and present it during the drivers and operation supervisors training. It is also important that this information is available on board, in order to assist the driver when executing the procedure. Communication can be established via different channels: oral, radio, written or preconfigured messages. In all cases, it is necessary to follow the protocols and maintain the clarity of the information.

2.15.3 ROAD CRASH RECORD

Describe the method of collection of data about the crashes. The method must specify location, type of damage (material or injury), type of incident (crash, running over, fall etc.) and type of vehicle. In addition, it is necessary to record the response time, how long the vehicle remained stopped due to the incident, when the operation was reestablished, among other relevant topics. The road crash record must be done using a clear form, with as few descriptive fields as possible, in order to guarantee that the data will follow the same pattern. The more complete the information, the more it will contribute to the operation of a safer system.


Dar es Salaam

2.16
KEY PERFORMANCE INDICATORS

Establish a list of and briefly explain the indicators, their relevance and why they need to be measured. It is essential that, if used, the indicators have a specific collection method. The information will also demonstrate benefits by enabling a comparison of the scenarios before and after the implementation of the bus-priority system.

World Resources Institute Brasil (2018b) proposes a quality indicators structure that can be used to evaluate a bus-priority system. The following sub-items highlight some indicators among several existing possibilities.

2.16.1 PASSENGER PER KILOMETER INDEX

This index represents the total of equivalent passengers divided by the total of kilometers traveled by all the vehicles of the system, considering the same period of evaluation. The objective of this indicator is to quickly measure the profitability of the system, comparing it with the operating cost per kilometer. This index can also be measured per route.

2.16.2 PASSENGERS PER VEHICLE

Indicates the average number of passengers transported per vehicle in the system. This data can be obtained with on and off boarding studies and can be used to estimate if the dimensions, capacity and frequency of the vehicles are adequate, optimizing the operation of the system.

2.16.3 AVERAGE SPEED AT PEAK HOUR

Represents the speed of the service during peak hours. It considers the arithmetic average of the operational speed of all trips occurred during the peak hour.

2.16.4 TRIPS FULFILMENT INDEX

The index measures the daily trips fulfilment considering the number of realized trips in relation to the number of scheduled trips.

2.16.5 TRIPS PUNCTUALITY INDEX

Measures the punctuality of departure times considering the number of the realized trips in relation to the number of scheduled trips.

2.16.6 REGULARITY INDEX

Indicates if the trips were done during their scheduled time.

2.16.7 PERCENTAGE OF VEHICLE OCCUPATION AT PEAK HOUR

Represents the total number of passengers inside the buses during the peak hour in relation to the capacity of the vehicles.

2.16.8 MEAN KILOMETER BETWEEN FAILURES (MKBF)

Refers to the distance traveled by the fleet over the month divided by the number of trip interruptions due to vehicle failures.

2.16.9 NUMBER OF ROAD CRASHES IN THE SYSTEM PER 100 THOUSAND PASSENGERS

Indicates the number of road crashes involving a vehicle of the transport system every 100 thousand passengers.

Dar es Salaam

2.16.10 CUSTOMERS GENERAL SATISFACTION WITH PUBLIC TRANSPORT

In a detailed and quantitative way, the survey evaluates the satisfaction of public transport customers in relation to quality factors. The World Resources Institute Brasil (2018a) proposes the Satisfaction Survey QualiÔnibus, which aims to:

- create a pattern of satisfaction surveys with a complete and flexible questionnaire that evaluates customers' satisfaction and needs in relation to each quality factor and measures the impact of interventions or improvements;
- obtain quantitative information to support the decision-making process;
- identify common challenges and opportunities among cities to discuss integrated solutions through a benchmarking process (WORLD RESOURCES INSTITUTE BRASIL, 2018b).

2.17
CONTINGENCY PROCEDURES

A contingency procedure is an instrument that defines policies, flows and general procedures to address cases of calamity, disaster or emergencies, considering their different phases, in a timely, efficient and effective way (BOGOTÁ, 2004). In case of any incident, the procedures guide the response of those responsible for the operation to ensure a fast, efficient, safe and standardized reestablishment of the service. Its main objectives are:

- articulate agile responses with municipal or metropolitan entities involved;
- verify the risk of possible threats;
- elaborate an activation scheme with an organizational structure adjusted to the needs of emergency responses;
- establish preventive measures to risky scenarios;
- minimize impacts in the operation;
- guarantee a fast reestablishment of the operation;
- identify and analyze risks that can lead to emergencies;
- offer tools to allow a safe and standard execution of the operational procedures by those exposed to risks;
- organize physical and human resources to address the contingencies;
- preserve fleet and infrastructure;
- preserve people and community's lives and integrity.

2.17.1 RISK MAPPING

The risks can be of different categories, as shown in Chart 3.

Based on situations likely to occur or already experienced in the operation, it is necessary to identify the most frequent risks that affect the operability, and thus elaborate contingency procedures for each one.

Chart 3 | **Risk examples**

CATEGORY	RISK FACTORS DESCRIPTION
Operational	Lane blocking Infrastructure damage Peak demand in terminals
Organizational	Training course failure Employee strike Lane maintenance failure
Public security	Aggression against drivers Vandalism of stations and terminals
Social	Protests in the dedicated bus-lane Arson
Environmental	Floods in the dedicated bus-lane Floods in stations and terminals
Information management	Customer information system failure Internal communication failures

Source: developed by the authors.

After assessing the risks, it is necessary to categorize them considering their impact and probability. For this, it can be used a scale of 1 to 3, as shown in Chart 4.

The multiplication of both factors (probability of occurrence and impact) results in an index for each risk, as shown in Chart 5.

Chart 4 | **Probability of occurrence and impact scale**

CATEGORY	PROBABILITY OF OCCURRENCE	IMPACT
Low	1	1
Average	2	2
High	3	3

Source: developed by the authors.

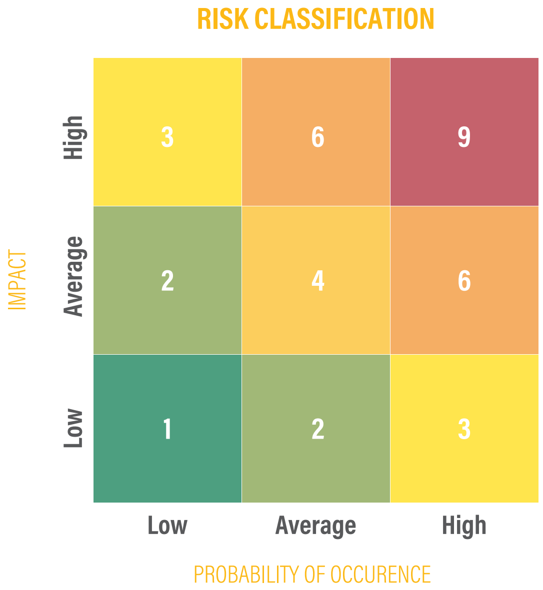
Chart 5 | **Example of risk categorization list**

CATEGORY	RISK FACTORS DESCRIPTION	PROBABILITY OF OCCURRENCE	IMPACT	PROBABILITY X IMPACT
Operational	Lane blocking	1	3	3
Operational	Peak demand in terminals	2	2	4
Public security	Aggression against drivers	1	2	2
Environmental	Floods in the bus-dedicated lane	1	3	3

Source: developed by the authors.

Based on this index, it is possible to build a probability and impact matrix for the risks in each category (operational, organizational, public security etc.), as seen in Figure 7.

Figure 7 | **Probability and impact matrix**



Source: developed by the authors.

The matrix helps to define priorities, starting with high impact and high probability risks. This process varies according to each transport system and the risks involved. A mechanical failure of a vehicle in a BRT corridor and a mechanical failure in a bus lane, for example, present similar risks, but very different impacts on the operation.

That is why it is essential to evaluate both the probability and impacts according to the local context. The specific combinations of probability and impact cause a risk to be classified according to its relevance, being:

- low (index 1 and 2), in green;
- moderate (index 3 and 4), in yellow;
- high (index 6 and 9), in orange and red.

2.17.2 PROCEDURE DEVELOPMENT

It is advisable to prepare technical sheets that describe in detail all activities involved in a given procedure, so that they have a logic interlink, in addition to designating who is responsible for each one (GOBIERNO DEL ESTADO DE MÉXICO, 2008). It is also possible to create a flowchart in which the actors and activities are briefly and clearly displayed (URBAN ELECTRIC TRANSPORT SYSTEM, 2012).

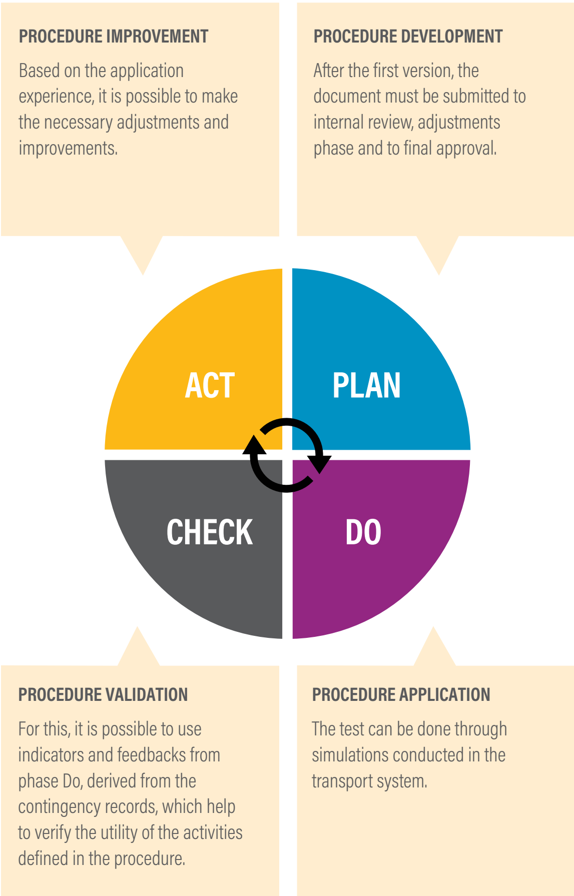
The recommendation is that each procedure has a code, allowing a direct and concise communication between the Operational Control Center and other employees in order to provide a timely response to contingencies.

The codes must be unique for each event and activity and easy to understand and memorize. A table with all codes and their respective incident allows an easy identification, especially at the beginning of the operation, when people are not yet familiar with this information.

PDCA Methodology (Plan, Do, Check, Act), seen in Figure 8, is widely used in the creation and improvement of procedures.

Stipulating a maximum time to solve problems can be a good practice for the system. The Check step of PDCA can assist in adjusting these goals in order to optimize the operation. It is also necessary to include an incident management guide, following the hierarchy of the operational team, in which simple decisions are left to field supervisors while major impact decisions (such as operation closings, operational reestablishments and service interruptions) are in charge of higher levels.

Figure 8 | **PDCA Methodology for elaborating contingency procedures**



Source: developed by the authors.

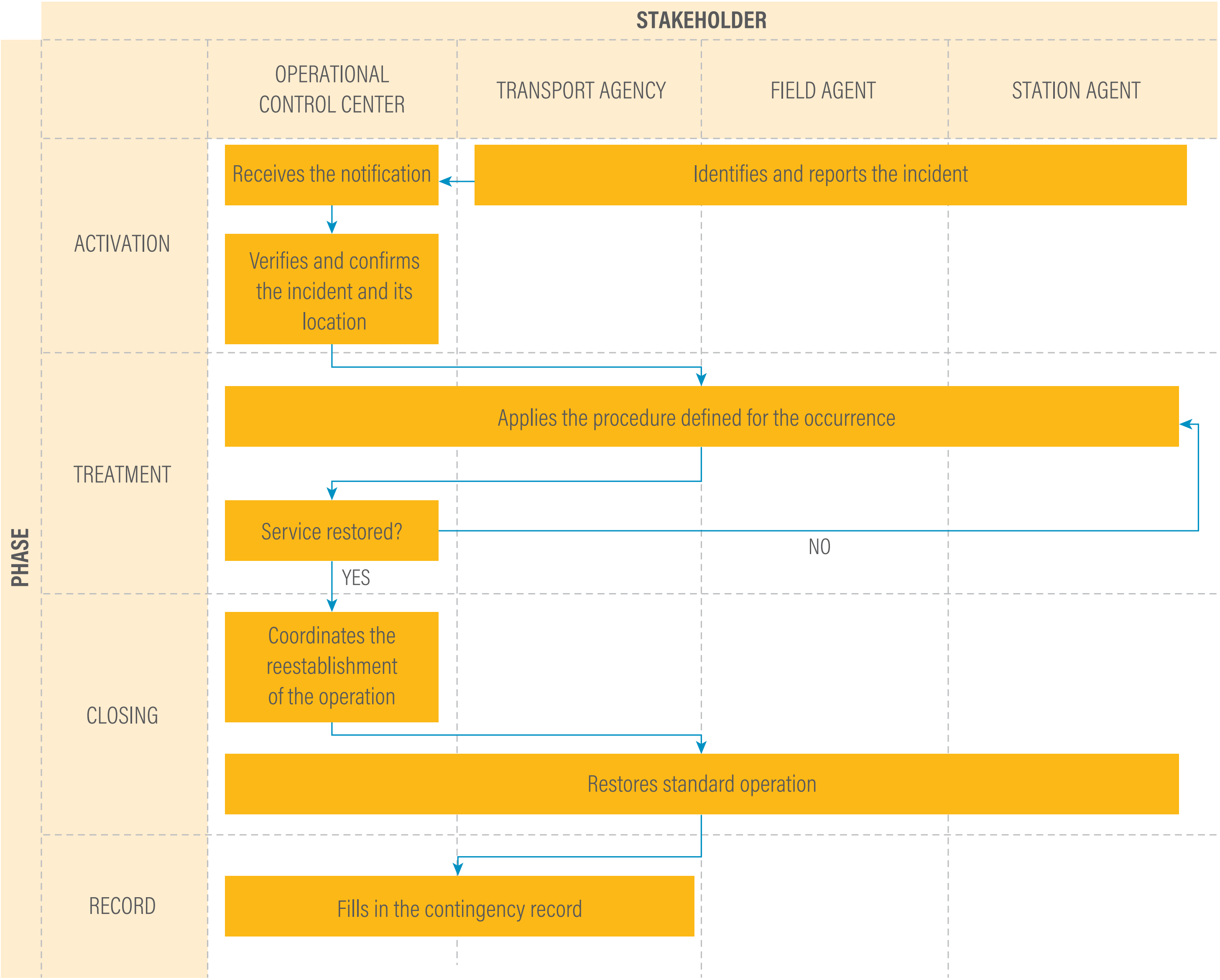
Chart 6 presents a layout example for the development of the procedures, and Figure 9 displays a flowchart for the implementation of procedures. The flowchart represents a generic procedure. The actors involved must be identified in the columns, and the execution stages and activities of the procedure must be listed in the lines. It is important that every activity is allocated in the column of its responsible. To make it easier to view and understand, it is possible to use different colors according to the actor responsible for the activity. Attachment 2 presents an example of contingency procedure to a better understanding of the items that must be in this document.

Chart 6 | **Example of a contingency procedure layout**

NAME OF THE PROCEDURE (CODE, VERSION, DATE OF LAST REVIEW)
· **Objective:** define the objective in detail
· **Scope:** where and when to apply procedure
· **Responsibility:** participants in the procedure
· **Activities:** list of activities that need to be executed in the procedure, in chronological order and designating who is responsible for each one
· **Flowchart:** figure of a flowchart for the implementation of the procedure (to make it easier to understand the activities described in the previous item)
· **Contingency record:** information that needs to be collected after each occurrence
· **References:** other documents to which the procedure is attached (contracts, laws etc.)
· **Information of who is responsible for development, review and adoption of the procedure**

Source: developed by the authors.

Figure 9 | **Example of contingency procedure flowchart**



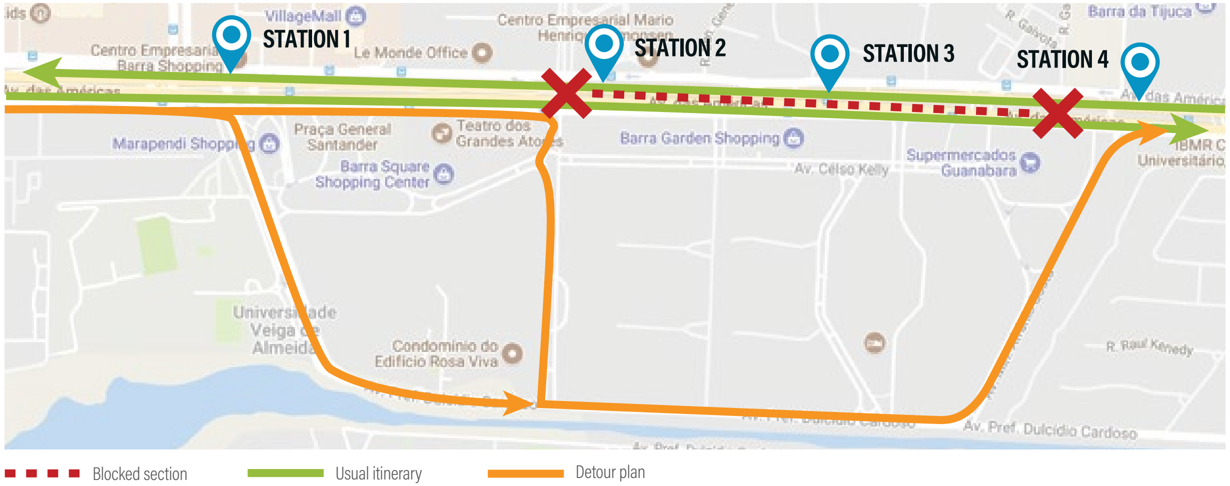
Source: developed by the authors.

2.18
DETOUR PLANS

It is essential to build detour plans to complement the total blocking contingency procedure, as highlighted in Box 2. The team responsible for the operation must be aware of these plans so that, in the event of an incident that fully obstructs the bus-dedicated lane, they are able to execute the plan and update the passenger information system in order to guide customers.

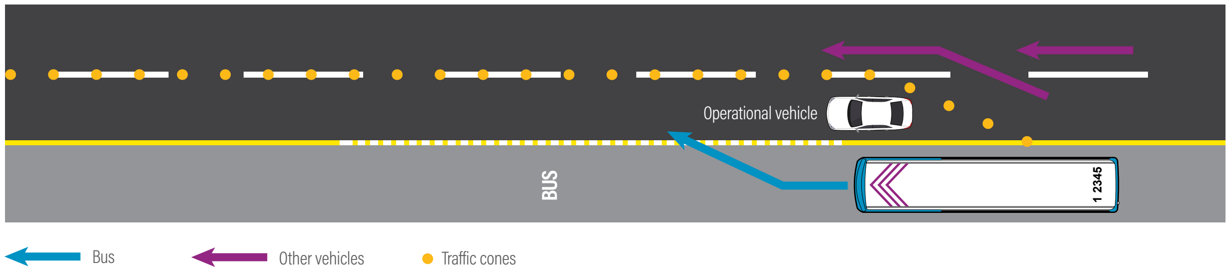
It is imperative that the drivers are also aware of the plan. Operational tests can be done to ensure that the vehicles are able to operate out of the dedicated infrastructure. In addition to define the streets for detours (which can be listed in this item and schematically characterized, as seen in Figure 10), this item also needs to describe how the vehicle will be moved out of the dedicated lane, as shown in Figure 11.

Figure 10 | **Example of detour plan**



Source: developed by the authors.

Figure 11 | **Plan for exiting the vehicle from the dedicated lane**



Source: developed by the authors.

Box 2 | TRANSOESTE LOT ZERO – RIO DE JANEIRO

Building a public transport dedicated infrastructure is a major step to the improvement of the system. However, it is necessary that the operations unit is also prepared, analyzing all risks, opportunities and internal challenges before starting service.

With this objective in mind, the Day One of Operation project for TransOeste BRT Lote Zero corridor, in Rio de Janeiro, proposed an immersion in the local system. Meetings with stakeholders and site visits to the service infrastructure contributed to the creation of the contingency procedures, which can be applied not only in the operation of Lote Zero, but of Rio's whole BRT system.

Lote Zero is an important section of the city's BRT, beginning at Alvorada Terminal (connection of TransOeste and TransCarioca corridors) and ending at Jardim Oceânico Terminal, where the BRT integrates with the Line 4 of the subway. A BRT system was a long-time need of Rio's residents to connect the southern region of the city to Barra da Tijuca, and it was the main transport mode during 2016 Olympic Games. The operational consortium of BRT Rio and WRI Brasil developed the contingency procedures in order to mitigate operational impacts in case of any incidents in the system.

Mapping and categorizing the risks that could affect the operation were the first steps. This is critical to ensure that the most relevant risks for the bus-priority system are covered by contingency procedures. After understanding the operation of the corridor and mapping the risks, it was possible to develop contingency procedures and detour plans.

During the Olympic Games, Rio's BRT went through situations contemplated in the contingency procedures. One such situation was high demand at the Parque Olímpico station. The station had to be temporarily closed to accommodate the in-flow of passengers, a case included in the peak demand procedure (MAGALHAES, 2016). Being better prepared for possible incidents that may occur in the system contributed to the success of BRT during the Olympics (CASTRO et al., 2017).

In addition to the contingency procedures and detour plans, the field visits also helped to identify some aspects that could be addressed to guarantee more quality in the operation of Lote Zero, such as infrastructure adjustments and road safety recommendations.

Rio de Janeiro

2.19 FORMS

This item must include the routine-checking forms of the transport system. Some activities that require forms are the following:

- daily report;
- executed mileage report;
- regularity and punctuality index report;
- vehicle checklist (Figure 12);
- vehicle inspection;
- road crash record.

Figure 12 | **Example of vehicle checklist**

Company:

Vehicle (No.):

Plate:

Current mileage:

Inspection date:

Year of manufacture:

Chassis manufacturer:

Body manufacturer:

OK	NOT OK	**A Vehicle external verification**
		A1 Glasses: conditions and fixation
		A2 Plate: position and legibility
		A3 Bumper: conditions and fixation
		A4 Bodywork and painting: conditions
		A5 Electronic display (itinerary)
		A6 Accessibility signage

OK	NOT OK	**B Vehicle internal verification**
		B1 Corridor: cleaning
		B2 Seats: conditions, proper attachment and cleaning
		B3 Indoor lighting: operation
		B4 Route map
		B5 Bell: operation (sound and display)
		B6 Emergency exits
		B7 Fire extinguisher and triangle

OK	NOT OK	**C Driver place**
		C1 Easy access and cleaning
		C2 Driving wheel: conditions and proper attachment
		C3 Seat: conditions, proper attachment and position
		C4 Seat belt: conditions, proper attachment and operation
		C5 Clutch pedal: verify use conditions
		C6 Brake pedal: verify use conditions
		C7 Hand brake: verify use conditions
		C8 Rear view mirrors: position
		C9 Horn: verify operation
		C10 Door control: closing, opening and sensors
		C11 Panel commands: verify operation

Source: based on GOBIERNO DEL ESTADO DE MÉXICO, 2012; SÃO PAULO TRANSPORTE S.A., 2009.

2.20 ATTACHMENTS

This item gathers other documents related to the operation of the transport system. Some examples are:

- visual identity manual;
- signage projects;
- technical standards;
- municipal laws, policies and guides related to public transport etc.


Brasília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CONCLUSION

This guide presents instructions on how to develop operational manuals and contingency procedures. These documents aim to define processes and plans that, once applied, ensure a timely, reliable, safe and high quality bus service. The cases presented here map different lessons learned from challenges faced by other public transport systems that started or expanded their operation. As main recommendations, the following stand out:

- it is essential to carefully evaluate the risks of start the operation before all elements of the system are prepared, regardless of political pressure;
- the success of a bus system relies on the engagement of municipal leaders in the conception and planning stages as well as in the implementation;
- it is necessary to make a deep analysis of the best institutional arrangement to manage the bus system during its planning, implementation and operation. This way, decision makers are able to delegate responsibilities, as there are other relevant projects that also need to be carried out;
- the development of an operation manual enables different elements to be planned together. This includes infrastructure, availability of vehicles and technological systems, customer information, trainings to drivers and others involved in the operation;

- contingency procedures must be established in order to ensure agile, standardized and coordinate responses in the event of any incident.

Bus-priority systems serve more than 32 million people every day in the world (BRT+ CENTRE OF EXCELLENCE; EMBARQ, 2017). Providing dedicated infrastructure to meet this demand is an important attribute to ensure an efficient public transport. However, to guarantee customer satisfaction and a good quality, other requirements are also necessary. Elements such as fleet, itineraries, system technologies, driver trainings, customer information service, ticketing and contingency procedures must be planned together and tested in advance. In addition, it is essential that all actors involved in the operation – public authority, operators, drivers, employees and customers – have the same expectations and are prepared to guarantee the correct functioning of the system since its Day One.

The development and continuous updating of operation manuals and procedures ensure that all actions related to the system are standardized. This uniformity leads to a higher quality service and helps to guarantee the satisfaction of public transport customers, converging to the goal of the QualiÔnibus Program developed by WRI Brasil.

Belo Horizonte

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APPENDIX 1: SUGGESTED CONTENT FOR THE OPERATIONAL MANUAL

1. MANAGEMENT AUTHORITY AND GENERAL REGULATIONS

1.1 Transport system management authority

1.2 Service supervision and control mechanisms

1.3 Operational contracts, laws and applicable regulation

2. MANUAL'S PURPOSE

3. MANUAL'S SCOPE

4. RESPONSIBILITY

5. DEFINITIONS

6. SYSTEM'S OBJECTIVES

7. SYSTEM'S INFRASTRUCTURE

7.1 Dedicated Bus Lanes
- 7.1.1 BRT corridor/bus corridor/"name x" bus lane
  - A) General features
  - B) Lines

7.2 Integration terminals

7.3 Transfer stations

7.4 Standard stations

7.5 Garages
- 7.5.1 Parking areas
- 7.5.2 Technical support areas

7.6 Signage

7.7 Operational Control Center

8. SYSTEM'S FLEET

8.1 Technical features

8.2 Vehicles visual identity

8.3 Vehicles environmental performance

9. OPERATION

9.1 Speed limits

9.2 Operation times in standard stations and bus stops

9.3 Operation times in integration terminals

9.4 Approaching and exit maneuvers

9.5 Operational plans

10. DRIVERS

10.1 Applicable norms

10.2 Training program

10.3 Medical exams
- 10.3.1 Physical exams
- 10.3.2 Psychological exams

10.4 Driving evaluation

10.5 Documents required to employment

10.6 Duties and obligations

11. ROUTE PLANNING SYSTEM

11.1 Operational information
- 11.1.1 Demand projection
- 11.1.2 Ticketing system information
- 11.1.3 Fleet control system information
- 11.1.4 Field study information

11.2 Project parameters for route planning
- 11.2.1 Vehicles capacity
- 11.2.2 Service times
- 11.2.3 Minimum and maximum headway between vehicles
- 11.2.4 Bus stops, stations and terminals capacity
- 11.2.5 Speed limits

11.3 Itineraries and timetable

APPENDIX 2: EXAMPLE CONTINGENCY PROCEDURE

P01 LANE BLOCKING

1. OBJECTIVE

Simple and clear description of the necessary actions to reduce the negative impact of a total blocking of the bus lane. The priority here are decisions that guarantee, in the following order: safety, continuity and quality of service.

2. SCOPE

Situations that cause a total blocking of the bus lanes (bus-dedicated lane and mixed-traffic lane).

3. RESPONSIBILITY

Users, controllers at the Operational Control Center, bus drivers, stations staff and operational support team.

4. DEFINITIONS

- OCC: Operational Control Center
- STATION STAFF: ticketing employee and/or those who control of the access to station.

5. ACTIVITIES

5.1 BLOCKING IDENTIFICATION

- The whole team involved in the operation of the system must immediately inform the OCC of any blocking that affects the usual operation. The communication must be clear and precise, informing the exact location and cause of the blocking and the existence or not of stuck buses.

Responsability

Users, controllers at the Operational Control Center, bus drivers, stations staff and others involved in the operation of the public transport system.

5.2 CONTINGENCY ACTIVATION

- Coordinate attention to the blocked lane with the municipal traffic agency, police, firefighters and other necessary authorities, depending on the cause of the blocking.

- Provide guidance to drivers and station staff so they can inform customers about the situation. Report the situation on social media, variable message panels and loudspeakers.

Responsible

OCC controllers responsible for the routes affected by the blocking.

5.3 SUPPORT IN THE COORDINATION WITH EMERGENCY AUTHORITIES AND POLICE

- Define who is responsible for support in the coordination with police, firefighters or other emergency-related entities, according to each situation.

Responsibility

OCC controllers responsible for the routes affected by the blocking and the responsible for the coordination with other entities.

Dar es Salaam

5.4 COORDINATION WITH OPERATIONAL SUPPORT TEAM

- Send the operational support team to the point where the lane is blocked and maintain permanent communication to ensure coordination of the situation.

Responsibility

OCC controllers responsible for the routes affected by the blocking.

5.5 FIELD SITUATION EVALUATION

- Identify the severity of the impact on the operation (number of stuck buses, feasibility of opening the lane, presence or absence of competent authorities) and inform the OCC.

Responsibility

Operational support team in the block point.

5.6 EXECUTION OF CONTINGENCY MEASURES

- Coordinate buses (according to available fleet and drivers) that need to be added in the operation, in order to mitigate the impact on service regularity.

- Available buses need to be inserted in the point most affected by the block, in order to reestablish the planned headway between vehicles.

Responsibility

OCC controllers responsible for the routes affected by the blocking.

CASE 1: AUTHORITIES CONFIRM THE OPENING OF THE LANE IN LESS THAN FIVE MINUTES

- Provide instructions to drivers to wait for the opening and inform affected customers.

Responsability

OCC controllers responsible for the routes affected by the blocking.

CASE 2: THE LANE BLOCK WILL CONTINUE FOR MORE THAN FIVE MINUTES AND THERE ARE FAVORABLE CONDITIONS TO DETOUR THE BUSES

- Identify (in the detour plan of the blocked section) which alternative offers the best safety conditions and then provide instructions to the operational support team to implement the authorized detour.

- Coordinate traffic agents and police to support the implementation of the authorized detour, if necessary.

Responsability

OCC controllers responsible for the routes affected by the blocking.

CASE 3: THE LANE BLOCK WILL CONTINUE FOR MORE THAN FIVE MINUTES AND THERE ARE NOT FAVORABLE CONDITIONS TO DETOUR THE BUSES

Considering conditions of the block, coordinate actions with the operational support team considering the following priorities:

- if there is a need to transfer customers to another bus, check safety conditions, a maximum walking distance of 500 meters, and the existence of sufficient personnel to control the action in the field;

- finish the trip with feeder buses from the blocking point;

- use of other lanes to continue the operation of affected route between extreme points;

- close the stations that cannot be served until the opening of the lane, following the procedure for closing stations.

Responsability

OCC controllers responsible for the routes affected by the blocking.

5.7 MONITOR THE SITUATUON UNTIL THE OPENING OF THE LANE

- Stay at the block point and keep the OCC informed of the evolution of the situation until it is solved.
- In case of any changes in the situation and/or new instructions from the OCC, execute them in field, maintaining communication with OCC.

Responsability

Operational support team in the block point.

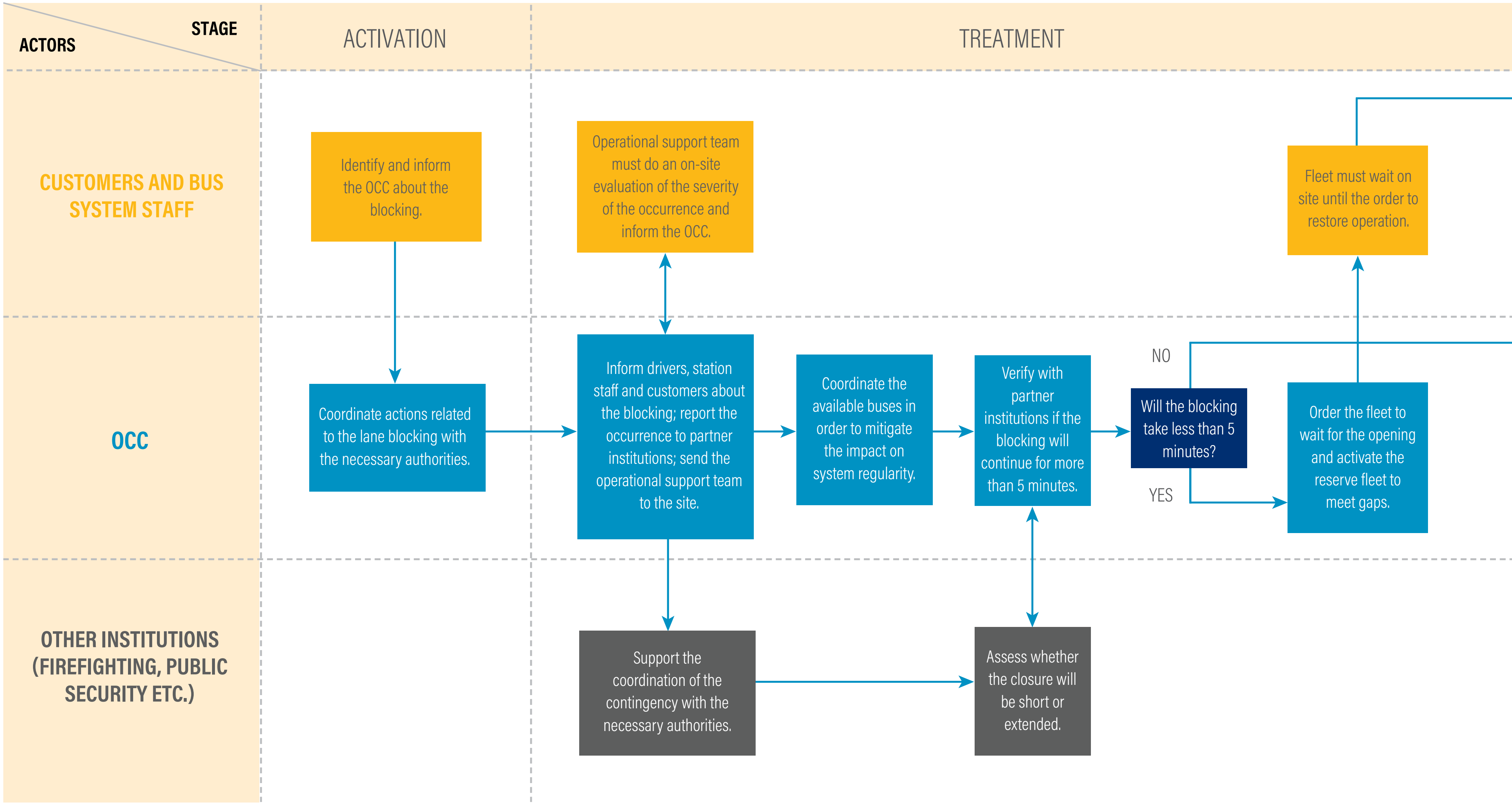
5.8 OPENING OF THE LANE

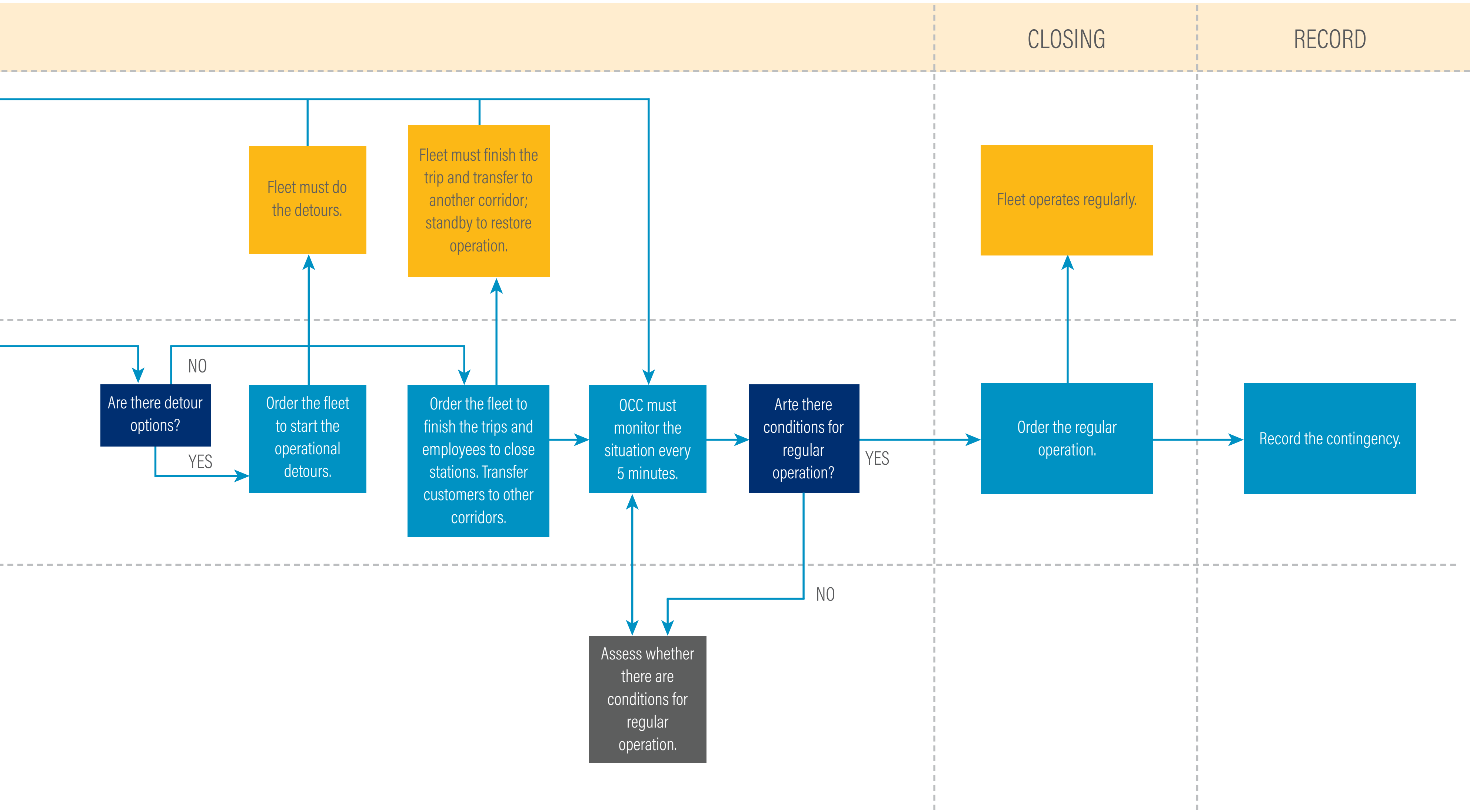
- Provide instructions to the operational support team to coordinate the reestablishment of the usual operation.
- Provide instructions to open affected stations.
- Inform the solution through social media, variable message panels and loudspeakers.
- Coordinate the reestablishment of itineraries and headways between vehicles according to available buses.

Responsability

OCC controllers responsible for the routes affected by the blocking.

6. FLOWCHART


STAGE
ACTORS
ACTIVATION
TREATMENT
CUSTOMERS AND BUS SYSTEM STAFF
OCC
OTHER INSTITUTIONS (FIREFIGHTING, PUBLIC SECURITY ETC.)
Identify and inform the OCC about the blocking.
Coordinate actions related to the lane blocking with the necessary authorities.
Operational support team must do an on-site evaluation of the severity of the occurrence and inform the OCC.
Inform drivers, station staff and customers about the blocking; report the occurrence to partner institutions; send the operational support team to the site.
Support the coordination of the contingency with the necessary authorities.
Coordinate the available buses in order to mitigate the impact on system regularity.
Verify with partner institutions if the blocking will continue for more than 5 minutes.
Assess whether the closure will be short or extended.
Will the blocking take less than 5 minutes?
NO
YES
Order the fleet to wait for the opening and activate the reserve fleet to meet gaps.
Fleet must wait on site until the order to restore operation.


CLOSING
RECORD
Fleet must do the detours.
Fleet must finish the trip and transfer to another corridor; standby to restore operation.
Fleet operates regularly.
NO
Are there detour options?
YES
Order the fleet to start the operational detours.
Order the fleet to finish the trips and employees to close stations. Transfer customers to other corridors.
OCC must monitor the situation every 5 minutes.
Arte there conditions for regular operation?
YES
Order the regular operation.
Record the contingency.
NO
Assess whether there are conditions for regular operation.

7. CONTINGENCY RECORD

It is necessary to fill the incident form with the following information:

Incident date	Date when the incident occurred.
Incident opening time	Time when the lane blocking was reported.
Incident closure time	Time when OCC ordered the reestablishment of the operation.
Local	Place where the blocking happened. If it is a station, fill in with its name; if it is along a corridor, fill in with the name of the closest station, approximate distance and geographical orientation. For example, 100 meters after XXX station, XXX direction.
Duration	Time elapsed between incident opening and closure.
Cause of the lane blocking	Cause of the lane blocking according to a categorization. For example, accident, protest, flood, and others.
Impact	Affected stations, estimate number of affected customers, stuck fleet.
Responsible for the operation	Name of the person responsible for the operation at OCC.
Responsible for the record	Name of the person responsible for filling in the form.

DEVELOPED	REVIEWED	ADOPTED

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ABOUT WRI BRASIL

WRI Brasil is a research institute that transforms big ideas into actions to protect the environment and promote economic opportunities and human well-being. It is focused on research and implementation of sustainable solutions oriented towards climate, forests, and cities. WRI Brasil combines technical excellence with political articulation and works in close collaboration with governments, private companies, universities and civil society.

WRI Brasil is part of World Resources Institute (WRI), a global research organization whose work extends to over 50 countries. WRI encompasses the work of almost 700 professionals in offices in Brazil, China, the United States, Mexico, India, Indonesia, Europe, Turkey and Africa.

ABOUT FEDEX CARES

FedEx Cares is a platform of investments in communities created by FedEx with the purpose of apply personal abilities and operational capacities of their team so they can make a difference in the world. The initiative enhances FedEx's priorities by helping people, communities and businesses to prosper. FedEx Cares has five priority areas, developed in line with the strengths of the business, and which carefully address some of the main global issues.

These areas include: Delivering for Good, Road Safety, Global Entrepreneurship, Employment Pathways and Sustainable Transport. Within the Sustainable Transport pillar, FedEx and WRI Ross Center for Sustainable Cities have worked together for the last eight years to improve the access to a sustainable and high quality public transport. Through research, capacity building and pilot projects, FedEx and WRI positively affected more than 4.9 million people who live in cities in Brazil, Mexico, China and India. To learn more about FedEx Cares and the goal of investing US$ 200 million in more than 200 global communities by 2020, visit cares.fedex.com.

ABOUT BRT+ CENTRE OF EXCELLENCE

Created in May 2010, BRT+ Centre of Excellence is funded by Volvo Research and Educational Foundations (VREF). Headquartered at the Pontifical Catholic University of Chile, in Santiago, the center comprises four other institutions: Massachusetts Institute of Technology (MIT), University of Pretoria (UP), University of Sydney (USyd) and WRI Ross center for Sustainable Cities.

The main purpose of the center if to develop a new program to the planning, design, financing, implementation and operation of BRT systems in different urban areas, providing objective guidance to decision makers regarding when and how BRT projects can effectively improve mobility and accessibility in cities.

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