



## Comparative Case Studies of Three IDB-supported Urban Transport Projects

# Lima Case Study Annex



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**POVERTY ANALYSIS**

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**This case study was prepared by Oscar Quintanilla and under the direction of Lynn Scholl and with consulting services of The Clean Air Institute (emissions analysis) and Grupo Limonta; and Professor Juan Pablo Bocarejo and Daniel Oviedo (poverty analysis)**

### **Acknowledgements**

The authors would like to thank Patricia Sadeghi for her support throughout the study, as well as Gerhard Menckhoff, and Jose Claudio Linhares Pires, for their very helpful comments on earlier drafts, Magdalena Fandiño and Joanne Green at the Clean Air Institute conducted the emissions analysis. The team would like to express gratitude to Juan Jose Arrué and Mariana Alegre at Grupo Limonta for their excellent survey work on low-income and poor residents living near the BRT system and Cesar Bouillon for his expert advice and guidance on the poverty analysis and survey. The authors are grateful to IDB Transport division staff, in particular Rafael Capristán, who provided valuable information and support for the case study as well as current and former World Bank staff who were involved in the project. This case study would not have been possible without the support of numerous individuals in national and local governments and members of civil society in Lima, Peru.

## I. INTRODUCTION

- 1.1 With growing urbanization and motorization, cities in Latin America and the Caribbean are facing increasing mobility challenges, lost productivity, and externalities such as congestion, poor air quality, and traffic accidents. As traditional bus systems are often characterized by aging bus fleets, poor service quality, and informality, cities have been looking at mass transit solutions to organize and improve their public transport systems. Following the innovations and success of Bogotá's *Transmilenio*, high-capacity bus rapid transit (BRT) systems are an option that cities of various sizes are seriously considering (Wright 2011).
- 1.2 Lima, a city of almost 9 million residents and more than 22 million daily trips, desperately needed a mass transit system. The Metropolitano, inaugurated in 2010, was Lima's first mass transit system, a BRT with a trunk and feeder configuration that includes a segregated busway for high-capacity articulated vehicles and characteristics that improve efficiency, such as off-vehicle fare collection and verification, platform-level boarding, and a mix of regular and express services. The system also offers higher-quality service: it is safer and more reliable, provides universal access, has dedicated stations and terminals, operates more hours than the traditional service, and complies with strict vehicle emission standards. Built by the Metropolitan Municipality of Lima (MML) with cofinancing from the IDB and the World Bank, and operated by private companies, the Metropolitano achieves the gold standard for BRT systems as defined by the Institute for Transportation and Development Policy (ITDP).
- 1.3 The project was a success in terms of mobility: it currently carries 590,000 passengers during a typical workday and has reduced average travel times by 34%. It has also achieved important emission reductions of local pollutants and greenhouse gases. On the other hand, the project also had several shortcomings that pose risks to its sustainability, created costs that were not accounted for, and missed important opportunities.
- 1.4 This case study, an input to a comparative project evaluation of IDB-supported urban transport projects, examines the project's design, implementation, results, and sustainability. It starts by presenting the context for the project and describing the project and IDB's participation. It then evaluates the project's relevance, implementation, and effectiveness, including a detailed analysis of air quality and poverty results. Finally, it discusses ongoing issues that affect sustainability and presents lessons for future IDB-supported urban transport projects.

## II. CONTEXT

- 2.1 Lima is not only Peru's capital city, but also its center of political and economic life. With a population of slightly above 8.7 million, the city represents about one-third of the population of the country.<sup>1</sup> It also generates half of the country's GDP (INEI 2013) and is home to the main port and international airport, which generate important freight transport activity. With recent income growth and a vibrant economy, passenger transport activity in Lima has increased considerably. A recent transport study estimated about 22.3 million trips per day in 2012, a 35% increase from the 16.5 million trips estimated in 2004.<sup>2</sup>
- 2.2 For at least two decades, Lima has suffered from increasing congestion, air pollution, and traffic accident rates (Bielich 2009). Multiple news reports, studies, and opinion surveys have found that congestion and the public transit systems are among the main concerns in Lima. Growing population, incomes, and motorization rates have all contributed to an increase in travel demand. This, together with urban sprawl that increases the length of trips, and a public transport system with old buses and poor quality, exacerbates congestion and air pollution, and causes losses in productivity for the city as a whole.
- 2.3 While this situation is in part a product of rapid urbanization and unplanned growth, it cannot be attributed to a lack of planning efforts. Lima has a tradition of planning for the future, with long-range planning initiatives in 1949, 1967, 1987, and 2013 (ONPU 1968; MML 1992; MML 2013). Each of these plans has provided direction for the emerging metropolis, but rapid urbanization, coupled with weak institutions and poor collaboration among government agencies, has rendered most planning efforts ineffective.<sup>3</sup> As Figure 1 shows, the burgeoning population has increased Lima's importance for Peru but has brought urban sprawl and lower population density.

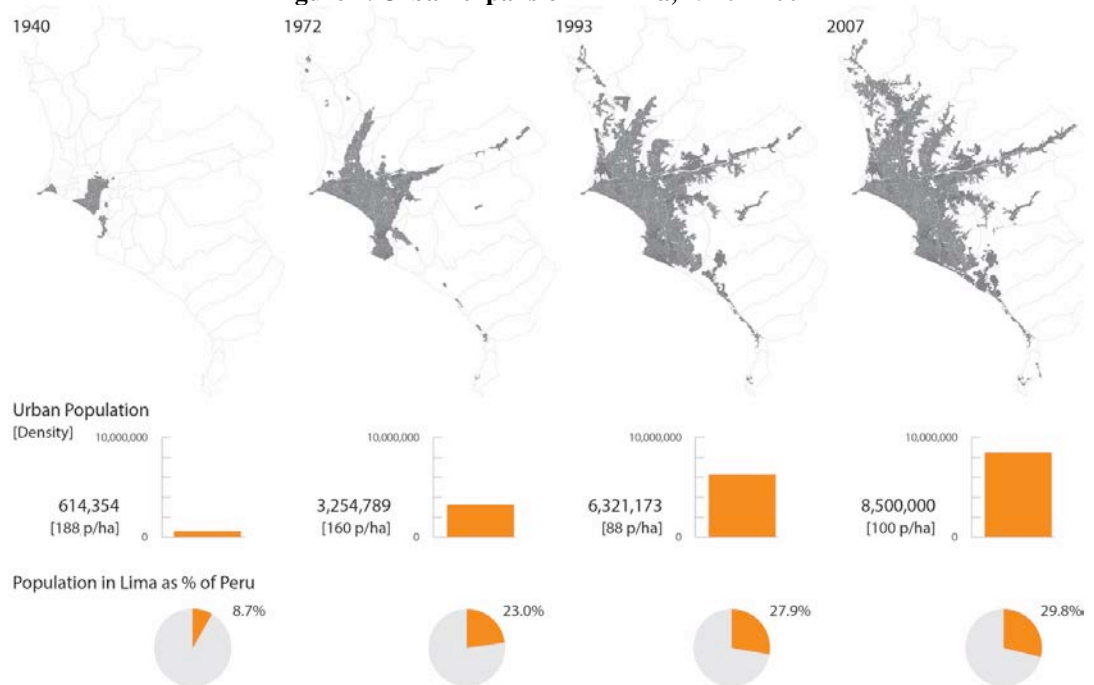
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<sup>1</sup> The city, as defined by the National Information Institute (known by its Spanish acronym INEI) and as understood in this report, includes the urban population of the provinces of Lima and Callao.

<sup>2</sup> Nippon Koei CO (2013). Of the total trips, 24% were done by walking, 16% by private vehicles, 10% by taxis or colectivos (taxis providing line-passenger service), and 50% by public transport.

<sup>3</sup> While the 1949 plan set a vision for Lima to become the political and economic center of Peru, the plans of 1967 and 1987 were only partially implemented and were unsuccessful in regulating the city's growth. The organization of the city was ultimately dictated by geography, with the poorest populations being pushed further out or concentrated in underserved areas.

**Figure 1. Urban expansion in Lima, 1940 - 2007**



Source: OVE, using data from INEI (1996 and 2007) and MML (1992 and 2013)

- 2.4 Until the middle of the 20<sup>th</sup> century, public transport services in Lima were provided by private companies. By the late 1960s a state-owned enterprise used the first segregated bus corridor in Latin America,<sup>4</sup> but it provided only very limited service as demand for public transport trips grew (Sanchez-León 1978). In 1990 the government calculated a deficit of 3,000 transport vehicles, which was to be solved by a series of liberalization measures (Bielich 2009), part of a general policy to privatize and deregulate the economy. In 1991, National Decree 651 liberalized the transport service, and among other things eliminated fare regulations, eliminated legal barriers to entry to any established route, and allowed any person or company to provide public transport service using any vehicle except trucks and motorcycles.<sup>5</sup> Days later Decree DS 080-91-EF lifted import tariffs for used vehicles, creating the conditions for an explosive growth in public transport vehicles from 10,500 to 47,000, and in taxis from 10,000 to 191,000.<sup>6</sup> These measures did not solve the problem of an undersupply of public transport vehicles; instead they created the incentives for smaller and cheaper buses and an oversupply of vehicles that created more congestion, air pollution, and more traffic accidents (Bielich 2009). By 1996 the municipality was already trying to regulate the transport service, registering routes and concessions, and publishing Local Ordinance 104, “*Reglamento del*

<sup>4</sup> The state-owned enterprise “Empresa Nacional de Transporte Urbano del Peru” (ENATRU) used the segregated corridor initially conceived as a rail-based mass transit line along the “Via Expresa”; it provided service until the early 1990s, when it went bankrupt after many years of financial trouble and its buses were transferred to the bus drivers.

<sup>5</sup> National Decree 651 (<http://www.congreso.gob.pe/ntley/Imagenes/DecretosLegislativos/00651.pdf>).

<sup>6</sup> Reports have different figures, but they all show the important growth in the number of vehicles in the city (WB 2012, IADB 2011).

*servicio público de transporte urbano e interurbano de pasajeros de ómnibus y otras modalidades para la provincial de Lima”.*

- 2.5 Lima’s administrative and political context presents challenges of its own. As Peru is a unitary state and Lima the center of its political and economic life, the central government has incentives to participate in major local decisions, including transport-planning efforts. For example, in the 1980s, while the city was implementing a system of segregated busways through a loan from the World Bank, a newly elected national government decided to pursue a rail-based system instead; as a result, the loan was canceled.<sup>7</sup> The city is made up of two independent provinces, Callao and Lima, each of which regulates the public transport service within its jurisdiction. Buses licensed in one province can run in the other, which has little power to regulate them. Each of the provinces is made up of independent municipalities,<sup>8</sup> which have their own elected local governments and are responsible for traffic along local streets and pedestrian connections. Furthermore, the national government is responsible for regulating interurban transport.<sup>9</sup> Efforts to establish a metropolitan transport authority have been unsuccessful because they were considered to contravene the decentralization principles that are part of the Constitution.

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<sup>7</sup> The first metro line was not completed at the time, and remained unfinished for over 25 years.

<sup>8</sup> The MML is made up of 43 districts.

<sup>9</sup> Dirección de Transporte Terrestre ([www.mtc.gob.pe](http://www.mtc.gob.pe)).



### III. THE PROJECT: CORREDOR SEGREGADO DE ALTA CAPACIDAD (COSAC 1)

- 3.1 In 2003, Lima's public transport vehicles were on average 16 years old –a very old fleet,<sup>10</sup> even compared to those of other Latin American cities. Lack of maintenance created important air quality and safety issues: contamination by fine particulate matter was 100% above levels considered safe by the World Health Organization,<sup>11</sup> and in 2003 there were 44,604 traffic accidents<sup>12</sup> (of which 779 were fatal); 78% of traffic fatalities were pedestrians (OMS, 2009)<sup>13</sup>. The congestion problems in the city affected everyone, but particularly poor people living in the outskirts of the city. An average trip for low-income workers took 90-180 minutes. While the public transport service was suboptimal, it provided a practical alternative to a great number of people: 78% of the trips were completed without transfers, and 90% of riders reached the system by walking an average of 5 minutes (MACROCONSULT 2005).
- 3.2 The Ministry of Transport declared the creation of an integrated public transit system a priority. With funding from Japanese grants administered by the World Bank, the Metropolitan Area Urban Transport Project was developed between 1996 and 2000. It became the basis for the Metropolitan Lima Urban Transport Program, financed in part with loans from IBRD and IDB, to increase mobility and reduce the social and environmental costs of transport for Metropolitan Lima. The project would start a transformation process for the delivery of public transport by connecting the most populous areas of the city to important employment centers.
- 3.3 The first line of this program, “El Metropolitano,”<sup>14</sup> is also the first mass public transit system in Lima. It consists of a BRT corridor connecting the northern and southern areas of Lima with the financial district, major universities, and the historic downtown. The corridor comprises 28.6 km of segregated busway, with 35 stations, two terminals, and a central transfer station. The system also has feeder routes that connect the two terminals with the surrounding neighborhoods. Some of the characteristics of this BRT system are level boarding through raised-platform buses, pre-boarding fare collection, high-capacity articulated buses along the trunk line, and an integrated fare structure for the service. A later phase was conceived to include an extension of the corridor to the north (Figure 2).
- 3.4 In addition to the infrastructure improvements, the program included structural changes to the way the service is provided. Whereas the preceding point-to-point services required 1,200 buses, El Metropolitano was expected to use only 600 buses to provide the same amount of service with improved quality, speed, and reliability. A number of features –

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<sup>10</sup> Low-capacity vehicles (minibuses and pick-ups) constituted about 90% of the public transport fleet, and buses accounted for only 10%.

<sup>11</sup> For particulates with a diameter of 2.5 micrometers or less, WHO suggests a level of 25 parts per million, while in Lima it is around 50 parts per million (emissions analysis).

<sup>12</sup> Source: <http://ditoe.minedu.gob.pe/Materiales%20DITOE/B14.pdf>

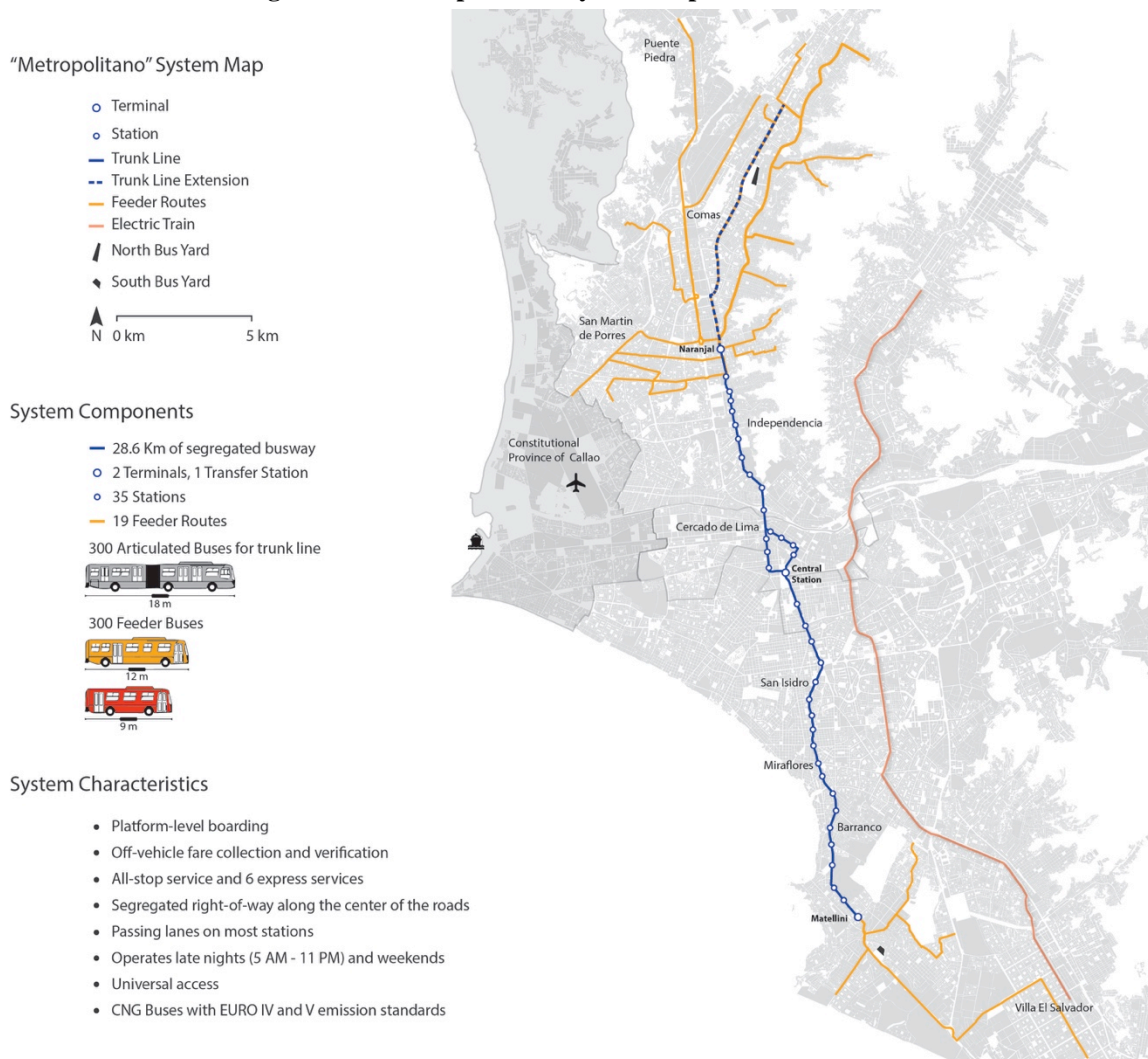
<sup>13</sup> [http://www.camara-alemana.org.pe/downloads/120328\\_2-ViasalFuturo\\_FundacionTransitemos.pdf](http://www.camara-alemana.org.pe/downloads/120328_2-ViasalFuturo_FundacionTransitemos.pdf)

<sup>14</sup> Originally called High Capacity Segregated Corridor (COSAC), the system is best known as El Metropolitano.

among them segregated lanes along the trunk corridor, platform-level boarding, passing lanes at most stations, and traffic light prioritization— were designed to significantly reduce travel times.

- 3.5 The service was initially envisioned to be structured in four separate lines of business, each one given in concession through competitive bidding processes: (i) operation and maintenance of 300 articulated buses and 300 feeder buses, (ii) the control center, (iii) compressed natural gas service stations, and (iv) the fare collection system. From a business model perspective, El Metropolitano changed the incentives and remuneration structure for drivers and bus owners. Four private companies that were selected under competitive bidding provide the service, and each is responsible for buying, maintaining, and operating a specific number of buses. The companies are also responsible for hiring bus drivers, who receive a monthly salary and benefits and work normal 40-hour weeks. This is a significant change from the model operating in the rest of the city, in which a company buys the rights to operate a route, but does not own buses or provide the service. Instead, this “afiliadora” charges each bus owner a fixed fee per bus, and bus drivers (engaged by the bus owners) compete for passengers since their remuneration is proportional to the fares collected each day.

**Figure 2. El Metropolitano: System map and characteristics**



Source: OVE, using GIS layers from MML, field observations, and administrative data from PROTRANSPORTE.

#### **IV. METROPOLITAN LIMA URBAN TRANSPORTATION PROGRAM (PE-0187)**

- 4.1 In 2003 IDB approved the Metropolitan Lima Urban Transportation Program (PTUL, PE-0187) as part of the financing package required to build and operate the first stage of Lima's public transport system, COSAC 1. The total public investment was originally estimated at US\$134.4 million, of which US\$90 million was jointly financed by loans of the IDB and the World Bank (US\$45 million each), and the rest by the MML. For both banks, these were the first loans to a subnational government in Peru: the borrower was the MML, with a sovereign guarantee from the central government (IDB 2003a). Unlike most other public transport projects, this effort didn't have the financial or technical support of the National Government.
- 4.2 Local political cycles have great influence on the timing of and support for urban transport projects. The planning of this loan started during the administration of Alberto

Andrade, who ran for reelection in 2002 with the BRT as his feature project but lost. In 2003, when the loan was approved, the mayor was Luis Castañeda, who had won against Andrade with a metro system as his proposal for Lima, and thus was initially reluctant to implement the project. Since Lima was unable to finance the cost of a metro system, the mayor eventually decided to support the BRT as the most feasible solution for the city.

- 4.3 IDB approved several grant operations to support preparation of the loan. In 2002, it approved a US\$490,000 grant (TC-0107023) to develop some of the pre-investment studies required for preparing the PTUL, including preliminary designs and environmental studies for the selected corridor (IDB 2002). In 2003 a grant (TC-0110056-PE) of US\$450,000 was approved to design and prepare bidding documents for Intelligent Transportation System technology, including the fare collection, bus operation control, and traffic signal control systems (IDB 2003c). Finally, a 2003 grant (TC-0108041) of US\$150,000 financed consulting services to analyze the viability of clean fuel technologies for the system (IDB 2003b).
- 4.4 The general objective of the loan was “to improve mobility conditions for the population of Metropolitan Lima, particularly among lower-income groups, and to reduce the private and social costs of providing and using mass public transportation.” By establishing a modern transport system with large-capacity buses and dedicated bus lanes, the project was also supposed to make employment and social services more accessible, particularly to the poorest population, shorten travel time, reduce the numbers of accidents, and reduce air pollution in Lima (IDB 2003a). As Table 1 summarizes the loan’s four major components included the infrastructure, institutional strengthening, promotion of sociopolitical viability, and studies and supervision.

**Table 1. PTUL loan components**

<b>Component</b>	<b>Main Activities</b>	<b>Cost in US\$ million</b>
I. Improvement of mobility and the urban environment	<ul style="list-style-type: none"> <li>• 28.6 km of dedicated arterial corridor</li> <li>• 35 stations, 2 terminals, and 2 intermediate terminals</li> <li>• Paving and upgrading of 50 km of feeder roads</li> <li>• Cycle paths, sidewalks, and pedestrian bridges</li> <li>• Restoration of public spaces at historic centers of Lima and Barranco</li> </ul>	86.8
II. Institutional strengthening and training	<ul style="list-style-type: none"> <li>• Revisions to the transport policy and regulatory framework</li> <li>• Design and implementation of concessions, including necessary regulations, bidding documents, and model contracts</li> <li>• Strengthening and training of PROTRANSPORTE</li> <li>• Strengthening and training of the Urban Transport Office of MML</li> </ul>	3.0
III. Promotion of sociopolitical viability	<ul style="list-style-type: none"> <li>• Communication and participation campaigns, including traffic education and highway safety measures</li> <li>• Measures for mitigating the impacts on current transport operators</li> </ul>	5.0
IV. Studies and supervision	<ul style="list-style-type: none"> <li>• Baseline describing socioeconomic status of users</li> <li>• Monitoring and evaluation of the program’s short-term socioeconomic impacts</li> <li>• Works supervision</li> <li>• Technical and environmental studies for the second phase of the system</li> </ul>	7.6

## V. EVALUATION OF RESULTS

5.1 The case study evaluates the project on four dimensions: relevance, efficiency, effectiveness, and sustainability. It is based on the collection of data, field notes and spatial analysis, interviews, and review of official documents and administrative data from PROTRANSPORTE. It seeks to answer four questions:

1. Was the project well designed with respect to its objectives and the needs of Lima?
2. What were the main challenges for implementing the project?
3. What are the results, and do they achieve the project's full potential in terms of increasing mobility, benefiting the poor, and improving air quality?
4. What lessons can Lima offer future BRT projects in terms of design, implementation, and sustainability?

### A. Relevance

5.2 **The loan supported the first mass transit system in Lima, financing the construction of a segregated bus corridor that connected the northern and southern cones with the center of the city, two of the most congested corridors, and providing two of the fastest-growing areas with access to major destinations.** Urban mass transit systems provide a relevant solution for the growing travel demand of a city experiencing rapid urbanization and motorization rates, particularly when replacing an obsolete and inefficient system. Not only does an oversupply of old buses create important externalities like congestion and air pollution, the quality of the service and income growth was pushing motorization rates even higher. The project proposed to connect two of the fastest-growing areas of the city, made up of mostly lower-income populations, and to provide access and travel savings to more than 600,000 passengers daily, which today would account for about 2.7% of the daily travel demand of the city.

5.3 **The system includes all the features of a full BRT, including level boarding, off-board fare collection, an integrated feeder and trunk system, and articulated buses.** El Metropolitano's infrastructure and operation components include a segregated right-of-way, off-vehicle fare collection and verification, platform-level boarding, a mix of regular and express service, and a programming and control center. The system also serves two of the highest-demand corridors, operates late at night and on weekends, complies with strict emission standards, offers universal access, provides articulated buses with appropriate door numbers and size, and stations with passing lanes and multiple docking bays. The system receives a gold standard score of 87.1/100 on the updated BRT standards.<sup>15</sup>

5.4 **While rapid implementation was needed to avoid the inaction created by short political cycles, insufficient public input during the design of the system has adversely affected the final design and construction strategies.** The design process

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<sup>15</sup> Based on field observations and information gathered by Gerhard Menckhoff, ITDP 2014.

was not participatory, so that many residents who were affected by the construction of the BRT had no input before the start of construction. Participation was limited to informing citizens about construction work, which led to protests from residents of the area most adversely affected by the BRT. The design of the system did not consider the barrier effects on local transportation or the changes in the urban environment of residential neighborhoods like Barranco, and did not give enough attention to the pedestrian connections to major stations. For example, the Javier Prado station, one of the biggest in the system, only has an exit on one side of a major arterial road, and passengers need to walk about five blocks in either direction just to be able to cross.

- 5.5 **Although the project's general design was very relevant, poor planning at the station level led to insufficient access to some stations, poor pedestrian connections, and missed opportunities in terms of land use and transport planning.** Given the long implementation periods of a BRT system –more than 7 years in Lima– detailed station-level planning is key to ensuring the success of the investment. Several stations in the city center and in the financial district –particularly those located along the Via Expresa– were designed with insufficient access and egress capacity, and with inadequate pedestrian connections to the rest of the city. Moreover, there were few efforts to coordinate the transport investments with real estate development around stations to create value for the system and for the city. A positive example is what was achieved in the central station after the mayor decided that it should be built underground instead of above ground as initially proposed. The station is now connected underground to an important mall that was redeveloped while the BRT system was being built. Other important deals could have been structured around the terminals if there had been more coordinated planning.
- 5.6 **A BRT system is not only infrastructure, but also a transformation of the public transport business that requires revised institutional arrangements and legal framework.** The loan supported the establishment of PROTRANSPORTE as an independent institution that would be responsible for managing the mass transit system, and the Bank provided technical assistance and institutional strengthening to support this process. Unlike other regional transportation agencies that have the full mandate for planning and managing regional transportation, resources and technical capacity limited PROTRANSPORTE to just managing the BRT system and depending on other institutions for reforms and complementary measures that were key to the success of the project. The transport division of the municipality is responsible for all other public transport routes in the city, while routes originating in Callao and other provinces provide additional service, and the national government is now responsible for the metro system.
- 5.7 **The risk analysis included in the loan proposal refers to the MML's ability to implement and repay the loan; however, as a public-private partnership the BRT should have had its own risk analysis and risk allocation strategy.** Risk analysis for projects that depend on a public-private partnership cannot be limited to the fiduciary risks to the IDB or the construction risks associated with implementing the project. IDBs project proposal identified potential risks, but the analysis was not comprehensive. Since the service was initially envisioned as four separate lines of business, the project as a whole required a more in-depth risk analysis and risk allocation strategy to create

appropriate incentives for ensuring high-quality and cost-effective service. Other potential risks that eventually materialized –for example, fluctuations in exchange rate, inflation, changes from preliminary designs, or lower than expected initial demand– were not properly discussed in IDB’s loan proposal.

- 5.8 **Peru’s national development bank, COFIDE, had to fully guarantee the loan for the private component of the BRT as no commercial bank had precedents for this type of product, there was no minimum revenue guarantee, and the choice of compressed natural gas (CNG) as fuel was risky for a full BRT system.** The financing of the rolling stock and the bus yards was particularly difficult in Peru since there was a lot of uncertainty about the operators’ ability to repay their loans. The financial structure did not provide any revenue guarantee, and meeting the expected passenger demand depended on factors beyond the control of the operators, like finishing the infrastructure on time or removing the competing bus routes. In 2005 the Peruvian government gave COFIDE the mandate to promote the use of natural gas, following their investment in the pipeline to connect Lima and Callao to the Camisea Gas Project, with one of such projects being the BRT system.<sup>16</sup> COFIDE was to provide up to US\$200 million to the private bus operators that won the concession contracts, for buying buses and building the infrastructure needed to support the operation (yards, maintenance shops, service stations). As a second-tier bank, COFIDE had to find a commercial bank willing to finance the private bus operators, but without any relevant precedent for underwriting this project, the private banks would not take any risks. With the full guarantee of COFIDE during construction and a 50/50 risk-sharing scheme during operations, a private bank established a loan facility for the operators that consisted of a 10-year repayment plan at 10-11% annual interest rate, with a two-year deferred payment period. The transport sector provided a new market for the bank, and the parent company had commercial real estate interests around the “Estación Central” that justified its involvement.<sup>17</sup>

## **B. Efficiency**

- 5.9 **Urban transport projects are particularly vulnerable to local political cycles, and their implementation and design are affected by the local political economy. After several delays and changes to the design of the project, El Metropolitano was opened partially to the public in May 2010, initially free of charge on a trial basis, and completed that October.** Local political cycles influenced the timing of and support for the project. Partly because of changes in the priorities of the city’s mayor, the construction of the BRT, approved in 2003, started only in 2006. Then, in 2010, the project opening was rushed so that the mayor could inaugurate the system before

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<sup>16</sup> Increasing the demand for natural gas would prove beneficial for COFIDE as they had to fulfill their commitments with the private investors, and El Metropolitano was a particularly convenient project to support. With a supply of 10 million cubic meters of gas per day and very little demand, COFIDE either had to promote projects that encouraged natural gas consumption or risk paying the investors the revenue guarantees agreed in the contract.

<sup>17</sup> The commercial bank decided to back out of the deal a few months after the start of operations when the operators were not repaying their loans, and COFIDE had to search for a new lender. However, the commercial property it redeveloped is proving to be a very successful investment for the parent company.

resigning to run his presidential campaign. The project was opened before the entire proposed infrastructure was completed (which is not uncommon in major urban investments), its institutional design affected by political economy limitations, and without the full implementation of complementary measures such as the reorganization of competing bus routes.

- 5.10 **Many of the implementation risks materialized –including changes in the exchange rate, rising construction costs, and citizen opposition– generating cost overruns over initial projections.** Infrastructure projects in densely populated areas face higher construction risks than greenfield projects, and this one in particular was approved with preliminary designs that were adjusted with further studies. While finishing the designs for the system, the city identified an 11 km extension of the trunk line to the north for a second phase, and changed the location of the northern bus yard to the north<sup>18</sup>, but no funding sources were identified to secure this extension. Initial implementation delays and poor communication with residents affected by the construction created intense opposition in Barranco (WB 2011). The World Bank hired a traffic safety expert to provide recommendations to the design of the system, leading to a need to adjust sections of the corridor to address the study's findings, but after the project was already under construction. Finally, rising construction costs and changes in the exchange rate<sup>19</sup> increased the initial budget from US\$125 million to around US\$300 million.<sup>20</sup>
- 5.11 **When construction costs put pressure on the budget, the municipality assumed key components that were initially to be financed by IDB, leaving the Bank with less involvement in the institutional and operational components of the BRT system.** Because of increases in the cost of materials and changes in the exchange rate, both loans focused on building the trunk line, increasing this component from US\$34.4 million to US\$64.06 million. Most of the other infrastructure, including a new integration terminal in downtown Lima, was covered with additional funding from the MML, which increased its participation from US\$22.4 million to US\$125.7 million. The municipality also assumed some aspects of the institutional and normative framework that initially were to receive stronger Bank support. The design of the contractual agreements for the public-private partnership was to be financed by the World Bank loan, but its implementation was delayed. At the same time, compensation measures to mitigate the impact on existing bus owners and drivers were postponed because political issues hindered the reorganization of the traditional bus system.
- 5.12 **When El Metropolitano was inaugurated, it was not fully operational: it had an incomplete set of articulated and feeder buses, and the city still needed to address**

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<sup>18</sup> The location of the bus yard near the terminal is critical for the operational efficiency of the system. With the current location, the articulated buses need to cover 7 km to get to and from the bus yard each day, and in order to refuel and rest for extended periods of time. The proposed extension would go right past the bus yard and reduce such inefficiencies.

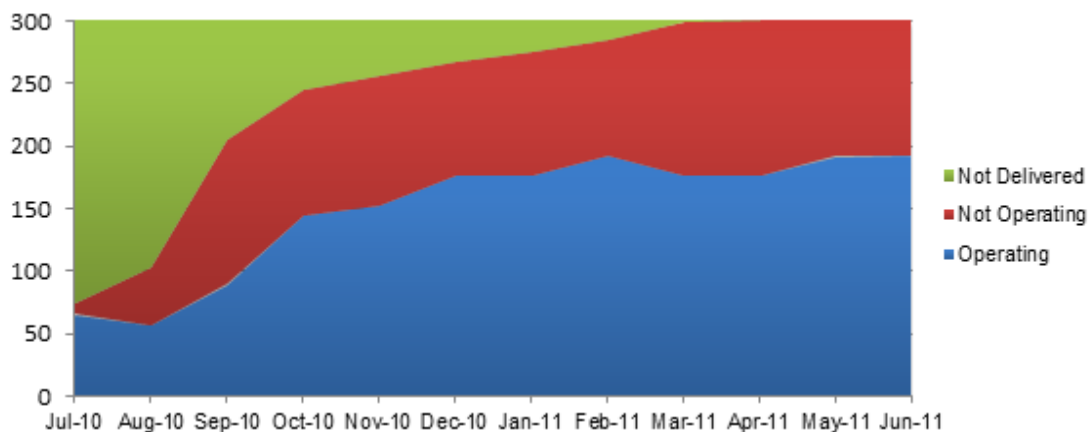
<sup>19</sup> The exchange rate risk materialized when the value of the loan was reduced by 20% with the appreciation of Peru's currency, from 3.50 soles per US\$1 in 2003, to 2.80 soles per US\$1 in 2008.

<sup>20</sup> According to the Project Completion Report, total costs for the project increased to US\$299 million; this excludes the cost of the private investments for buying the rolling stock and setting up the bus yards.



**the removal of competing service along the corridor.** Although the initially planned system was built, the bus yard ended up 7 km north of the terminal because of lack of land further south. The trunk line was to be extended to connect the bus yard, reduce the length of feeder routes, and increase potential ridership by more than 100,000 passengers, but this extension has not yet been built.<sup>21</sup> This gap in the infrastructure generates important costs and reduces the efficiency of the system: some feeder routes are very long,<sup>22</sup> and articulated buses travel several kilometers without any passengers. When the system opened, only the southern portion was complete and only 22% of the planned articulated buses were in operation.<sup>23</sup> Several months later, in mid-2011, 36% of the articulated buses were still out of service<sup>24</sup> (Figure 3). Finally, important complementary measures that had significant political costs were not implemented before opening day, including the reorganization of existing bus routes and removing direct competitors from the corridor, and launching the bus scrapping program to reduce the number of old polluting buses in the city. The administration's zero-impact policy and several agreements between bus owners and the municipality stalled the removal of the competing service.

**Figure 3. Delayed operation of articulated buses (in number of buses)**



Source: OVE, using administrative data from yard operators.

- 5.13 **The initial results were not promising: ridership was only a third of the projected demand, headways were long, and service quality did not create sufficient value for users.** During the first few months the system was significantly below ridership expectations, with about 220,000 passengers during a typical workday in 2010, and

<sup>21</sup> When the loan was approved with preliminary designs, the trunk line was expected to be 28.6 km long. During more detailed studies it was decided that extending the trunk line to the north by 11 km to Chimpu Ocllo and building an additional 17 stations would reduce the distance traveled by feeders and increase overall demand to up to 713,000 passengers per day.

<sup>22</sup> Some feeder routes are 14-17 km long, almost half the distance of the trunk line.

<sup>23</sup> The northern half of the infrastructure was completed by October 2010.

<sup>24</sup> The slow issuance of permits and attempts to increase the number of passengers per vehicle kilometer travelled were among the reasons for this delay.

380,000 in 2011. Among the issues identified as responsible were users' dissatisfaction with long headways<sup>25</sup> and crowded buses. The fare structure was not properly designed, leaving the price of feeder buses uncompetitive and not charging enough for the portion with dedicated infrastructure (see Box 1). Finally, the continued competition of the traditional bus system offering point-to-point service along the same corridor as the BRT further reduced the demand for the BRT.

**Box 1. Fare structure adjustments**

In November 2012, after months of financial losses and insufficient ridership, El Metropolitano changed its fare structure to better capture passengers' willingness to pay, and to eliminate the extra fare for transferring from the trunk to the feeder lines. Initially, fares were 1.5 soles on the trunk line, and an additional 0.80 soles for riding the feeders. This fare structure was not competitively priced for the feeders, since most users could use a minibús that would charge 0.5 soles for short distances, enough to reach the terminal and transfer to the trunk line. The structure was not attributing the full value to the users' benefiting from the dedicated infrastructure, since most travel-time savings happened along the trunk segment, for which the fare was only 1.5 soles.

After several discussions between bus operators and PROTRANSPORTE, and a decision-making process in which a committee made up mostly of bus operators can establish new fares, the fare was changed to a structure in which using only the trunk line, or the trunk and feeders in the same trip, would cost 2 soles<sup>26</sup>, while using only the feeder cost 1 sol. This new structure provided a cross-subsidy from the users of the trunk line to the users of both feeder and articulated buses, while better representing the benefit of riding high-capacity vehicles along segregated bus lanes. Finally, while the total number of daily trips was only slightly improved, average fare per passenger increased by 11.6%, providing more fare revenue to cover operating expenses.

Indicator (daily trips)	Three months before fare integration (August – October 2012)	Three months after fare integration (January – March 2013)
Trunk-only passengers	268,676	247,055
Feeder-only passengers	64,694	69,675
Daily integrated trips	59,365	82,738
Total daily trips	392,736	399,469
% integrated trips / total	15.1%	20.7%
Average fare per passenger	1.21 soles	1.35 soles

Source: OVE, using administrative data from PROTRANSPORTE.

- 5.14 **The service has seen important improvements, including new feeder routes and the progressive adjustment of express service, making full use of the busway infrastructure and providing a better match between travel demand and services provided.** After the poor initial results PROTRANSPORTE and the bus operators have worked to improve the operation of the system. In response to low ridership and crowded buses, origin-destination studies financed by the IDB helped design new feeder routes

<sup>25</sup> Headway is the time a bus takes to cover the distance between the bus covering the same route that is ahead.

<sup>26</sup> The fare was recently raised again to 2.50 soles in February 2015, with feeder fares reduced to 50 cents

and recommended new express services. The latest addition is a “super express” service between the north terminal, Naranjal, and the financial district in San Isidro. This alternative provides nonstop service between the most heavily used stations during peak hour. Other adjustments include station redesigns and better communication strategies to promote the services offered by El Metropolitano.

- 5.15 **IDB accompanied the design and implementation of the infrastructure component extensively, but shortcomings in assessing the results of the BRT system are reflected in the monitoring and evaluation of the project.** The project team completed regular visits and progress monitoring of the infrastructure component, and both IDB and WB financed specific studies to address issues like traffic safety, adjusting the design of the feeder routes, or responding to complaints by residents (WB 2012 and IDB 2011). The BRT was also built with information technology components that allow for a live monitoring and adjustment of the operation, including automated fare collection, GPS on all buses, and a centralized control center. On the other hand, the indicators and systems for monitoring air quality improvements or mobility for the poor were not fully implemented and created difficulties for assessing project results (emissions analysis).

## **C. Effectiveness**

- 5.16 The loan sets out specific goals for measuring the achievement of the objectives of improving mobility conditions in Lima, and in particular increasing mobility among lower-income groups, shortening travel time, reducing accidents, and reducing air pollution: it aimed at improving travel time along the corridor by 25%; reducing traffic accidents by 40%; provide service to 400,000 passengers,<sup>27</sup> with at least 60% from socioeconomic strata C, D, and E; and reducing pollution from fine particulate matter (PM 2.5) by 20%, and from CO<sub>2</sub> by 15%.

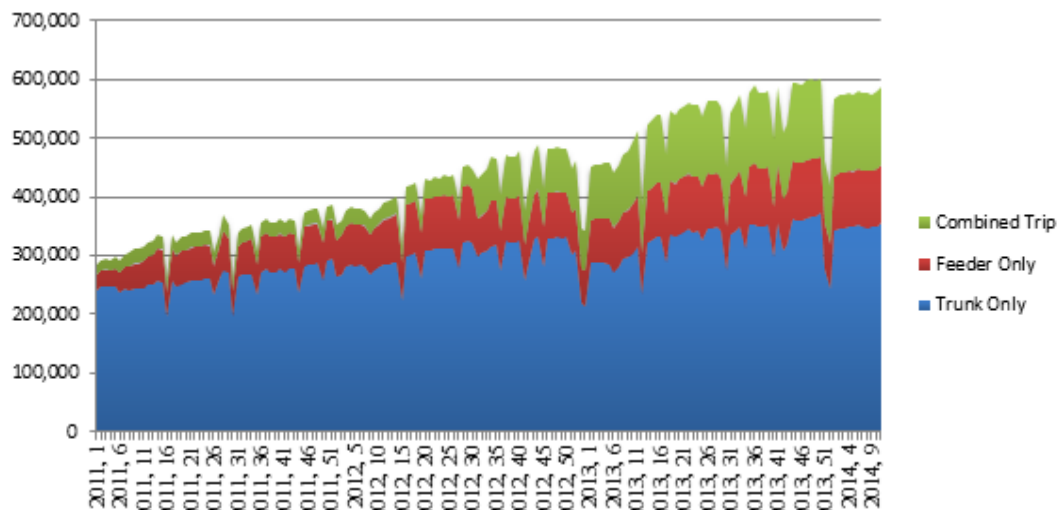
### **1. Mobility performance**

- 5.17 **The system has come a long way from its initial results, gradually reaching its projected demand and living up to its promise of transforming public transportation in Lima.** As a result of the adjustments to the fare and the express service, and the full deployment of the bus fleet, El Metropolitano has steadily increased its ridership. On a typical weekday in March 2014, it provided service for around 590,000 passengers, a significant improvement over the 290,000 passengers on a typical weekday in early 2011 (see Figure 4). The ridership has also benefited from the perceived and actual timesaving for users, the continuous improvement to the station infrastructure, and outreach and communication campaigns. Metropolitano’s users now represent 5.3% of the daily public transport trips in Lima.

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<sup>27</sup> The ridership figure was revised once the system had final designs, in which 630,000 was established as the projected demand.

**Figure 4. Average number of weekday passengers, by type of trip**



Source: OVE, using administrative data from PROTRANSPORTE.

- 5.18 **BRT systems have the potential to greatly improve performance and efficiency relative to traditional bus systems, offering faster and more reliable service, with higher productivity in terms of vehicle kilometers travelled and number of vehicles.** The transformation from a point-to-point bus system to an integrated trunk-feeder system, also known as hub-and-spoke, increases the general efficiency by reducing the number of vehicles and kilometers travelled needed to provide the same amount of trips. In Lima, operational productivity was increased from 1.59-1.62 passengers per kilometer in the traditional system, to around 6.13 in the articulated buses and 2.86 in the feeder buses by June 2013.<sup>28</sup> On average, each articulated bus carried 1,282 passengers a day, and the feeder buses 731. During peak hours, PROTRANSPORTE reports volumes of 32,000 passengers per hour per direction in the most heavily traveled sections, a volume on the higher end of recorded BRT capacity. Finally, commercial speeds for the system average 20 km/h for regular service, and much higher speeds for express services.
- 5.19 **The project offers significant travel-time savings for people travelling from the northern and southern parts of the city toward the center, surpassing the initial goal of reducing times by 25%.** The dedicated infrastructure and the different services options have allowed users reduce their travel times by up to 34%, according to PROTRANSPORTE. Such savings for almost 600,000 passengers on a typical workday represent a substantial productivity gain for the city. This timesaving is particularly important for users whose origin and destination are located close to the system. However, travel times might have increased for those living outside the coverage area, since the system could have increased the number of transfers required for completing trips, particularly for low-income population groups, from 1.4 to 2.5 on average. Also, the system has affected mobility for local trips within particular city districts like

<sup>28</sup>

Calculated from weekly passengers and programmed kilometers data from PROTRANSPORTE.

Barranco (see Box 2), where the segregated busway created a barrier effect dividing the district in two, and displaced traffic to the more historic and monumental part of the district. At grade mass transit, although beneficial for longer distance travel, creates costs for local travel and impacts outside the corridor that are not properly accounted for.

**Box 2. Regional benefits, local costs: The impact of El Metropolitano on local mobility**

Like most mass transit, El Metropolitano was a regional project, providing significant timesaving for residents of the most distant parts of the city by providing high-capacity buses along a segregated right of way. The benefits for the city as a whole are unquestionable, reducing users' average travel time by an average of 34%. While from a transport engineering perspective this is a total success, mass transit systems can also greatly alter local mobility and have effects on the urban environment that are mostly unaccounted for. In Barranco, a mostly residential district in the southeast part of Lima that was designated as historic in 1972, the at-grade segregated busway created a barrier between the east and west sections of the district and disrupted local traffic patterns, and delays in construction only added to the residents' frustration.

After intense opposition to the project and a request by residents of Barranco, an independent review panel found several shortcomings that made the project a threat to the historical character of the district. Among other things, the panel found little analysis of the environmental impacts beyond the corridor, particularly changes to pedestrian and vehicular flows, and a lack of measures to mitigate these potentially negative effects. Also, the panel confirmed that the citizen participation process failed during the design and most of the implementation of the project. Finally, the report verifies that there was no detailed analysis of the potential impacts of the project on the cultural value of the historic neighborhood, or of the rerouted traffic on buildings and public spaces of interest (WB 2011).

Although some improvements were made to the urban design of the system to address citizen concerns, the barrier effect and the effects on local traffic patterns remain in place. Heavier southbound traffic remains in the street closer to the historical portion of the district, while the busway cuts the district in two. The lack of citizen input and poor urban design are aspects that can be improved in future projects if the metrics used are not only passenger volume and travel speed, but overall value created for the city and its residents, from both a transport and from an urban environment perspective.

5.20 **Despite the impressive results in terms of overall mobility, timesaving, and operational efficiency, the system still has room for improvement.** Although the productivity measures are below initial estimates of 9 passengers per vehicle kilometer (IPK) and 1,900 passengers per bus, having a high IPK can mean both a system with many short-distance users, or a system with overcrowded buses, especially if users are heavily concentrated during the peak hours and in a certain direction, as in Lima. The system does have some potential efficiency improvements. For example, at midday most of the demand is concentrated between UNI and Canaval y Moreira stations, in the middle of the system; but since there are insufficient technical turnarounds, the buses must continue all the way to the north terminal (seven additional stops) to change direction. This limits the flexibility of the service and its ability to adjust to changing travel patterns during the day. Bus operators have reported issues with the control center, which was originally going to be contracted as a separate business, but ended up in the control of PROTRANSPORTE –not a bad thing in itself, but the control system needs very specific guidelines to achieve a balance between service levels and cost. Finally, some stations located in downtown Lima and in the financial district of San Isidro are still overcrowded, mostly because of insufficient access and egress capacity.

5.21 **Users recognize that El Metropolitano represents a significant improvement over the service quality offered by the traditional bus system.** According to a user survey in 2011 by Protransporte, 82% of users rated the service of El Metropolitano as good or

very good, a significant improvement over the 13.4% that were satisfied with the previous system, and above the project goal of at least 60% user satisfaction. More recent surveys from Lima Como Vamos<sup>29</sup> place user satisfaction of El Metropolitano between 66% (2012) and 58% (2014), with speed as the main characteristic of the system. Users appreciate the improvement in service, which in turn has encouraged civic behavior among its users by establishing rules and offering a more predictable service. There have been efforts to train drivers and service staff, and to keep stations and buses clean and in good condition. However, several shortfalls have prevented the service from reaching even higher levels of satisfaction. The system for communicating delays and unexpected changes is not reaching passengers effectively, and users report several issues with the information available in stations and inside the buses. Finally, although the concession contracts include liquidated damages as penalties for low-quality service, these are not being enforced, and the contracts themselves do not include clear quality metrics that reflect on the compensation of the bus operators.

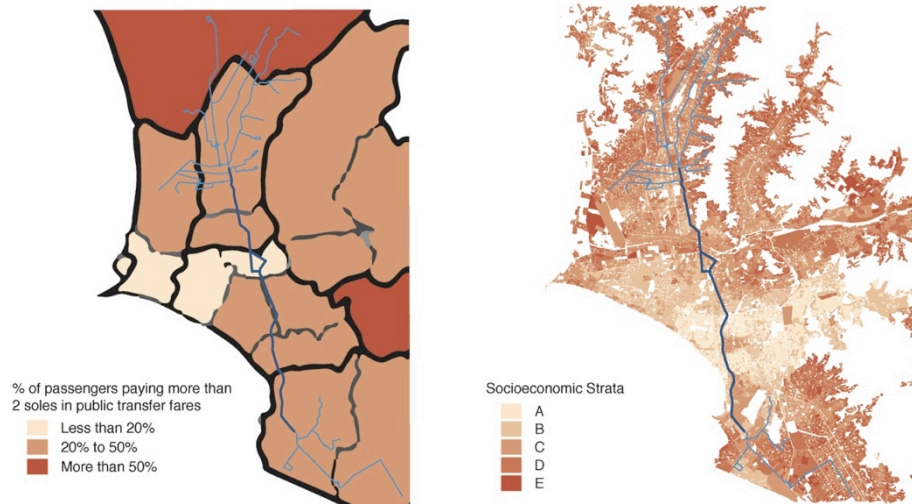
## 2. Improving mobility for the poor

- 5.22 **While PTUL did not specify social inclusion and equity goals, the loan proposal approved by IDB explicitly includes increasing mobility for the poorest as an objective.** The purpose of the PTUL, both stated and perceived, was to reduce congestion and improve air quality by improving the public transport system along one of the most heavily used corridors. However, the loan approved by IDB (PE-0187) does have the goal of providing mobility for the poorest population groups, with the expectation that at least 60% of the users belong to socioeconomic strata C, D, and E (see Poverty Analysis) .
- 5.23 **The system is designed to connect the poorest areas of the city, but there is no evidence that targeted efforts were made to increase mobility for low-income groups.** From an alignment point of view, the system, and particularly the feeder routes, provides access to the poorest areas of the city in the northern and southern cones, regions where at the time of loan proposal, 91-92% of the population were living below the poverty line. In addition, in the center of the city, some neighborhoods had poverty rates as high as 84% (Loan Proposal, PE0187, 2004). As Figure 5 shows, the feeder routes reach far into the poorest neighborhoods and connect these communities with the terminals. While this in itself is very positive, without active efforts to reach lower-income populations the results can be underwhelming. For example, current fare levels might prove beneficial for those heading to the financial district or downtown Lima, but it might still be too high to increase mobility for people traveling to closer destinations.

<sup>29</sup>

Lima Como Vamos is a representative perception survey about a wide array of issues faced by residents of Lima. Public transport is one of the top three concerns of interviewed people. Lima Como Vamos, Observatorio Ciudadano ([www.limacomovamos.org](http://www.limacomovamos.org)).

**Figure 5. Poverty, cost of transportation, and the BRT**



Source: OVE, using the 2007 census data from INEI, route alignment from MML, and results from a transport survey (Nippon Koei CO 2004).

- 5.24 **Several design features of the system, although beneficial in terms of efficiency and overall capacity, limit the potential mobility benefits for lower-income population groups.** People living the farthest benefit more from the mass transit system, if the system takes them to their destination. The fact that the feeder buses reach far into the poorest areas could represent a substantial mobility improvement, but their sole destination is the BRT terminal –and lower-income population groups may well wish to reach other destinations. The lack of integration with the rest of the public transport system could result in inefficient transfers and costs for the very poor that the BRT is trying to help. Furthermore, the deployment of feeders can reduce the availability of previously existing transport routes. The initial fare was set at the higher bound of the initially planned range; people living the farthest from the center were charged two fares –one for the feeder and a second for the trunk line– for a total of 2.30 soles. Most of the potential users continued using the traditional bus system, which offered trips starting from 0.5 soles.<sup>30</sup> By contrast, users of the trunk line only, who received most of the benefits of the dedicated infrastructure, did not pay enough. As discussed earlier, the change in fare structure improved the percentage of combined trips and increased the use of the feeder routes while not affecting the trunk line ridership. El Metropolitano also offers special fares for seniors, schoolchildren, and university students, which can provide relief for working families but are not in any way targeted.<sup>31</sup> A family of four with an average family income of 1,100 soles would pay 24.5% of the family income for using the BRT system.<sup>32</sup>

<sup>30</sup> Fare is distance-based, and the shortest trips cost 0.5 soles.

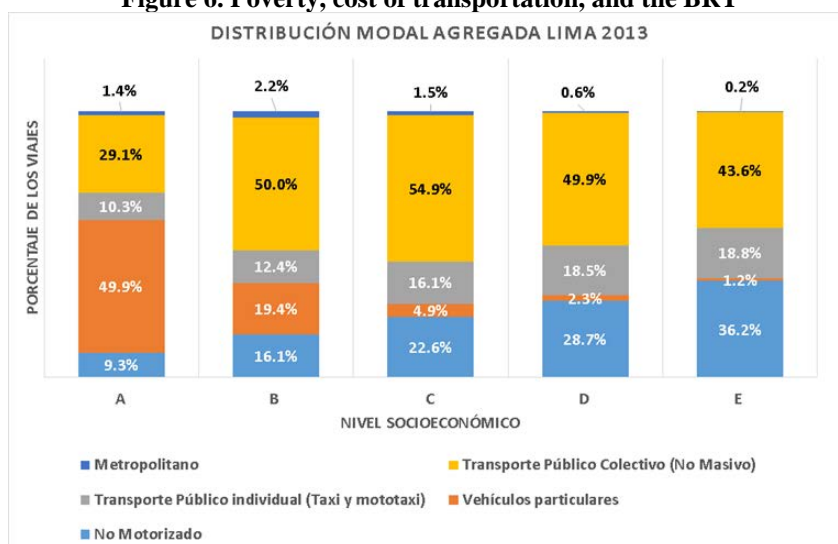
<sup>31</sup> University students pay 50% of the public transport fare and schoolchildren 30%; police, military personnel, and other uniformed public servants do not pay to use the public transport system.

<sup>32</sup> Calculated using 1.35 soles as average fare, 50 monthly trips per family member, and an average family income of 1,100 soles.



5.25 **The project is reaching its goal of having 60% of users in strata C, D, and E; although the typical user is a young professional from socioeconomic strata B and C, with office jobs in downtown Lima and the financial district.** According to data from a recent origin-destination survey, only 43% of users of the BRT system belong to strata D and E. This can also be observed with the modal split by socioeconomic strata: in the first three (A thru C), trips in the Metropolitano represent 1.4-2.2% of the total trips of each stratum, while in D and E, these trips represent 0.2-0.6% (see Figure 6). Similarly, a market analysis found the typical user to be young (under 30) and traveling from the northern districts of Lima toward the financial district of San Isidro. In fact, a survey conducted by OVE in the area of influence of the BRT in low-income and poor neighborhoods found that the poor use the system at lower rates than the non-poor and the primary reason stated was that the system did not serve their destinations (67% of poor who don't use the BRT regularly). The second reason cited was long lines to charge cards and enter buses (21%), followed by delays in bus arrival (13%).<sup>33</sup> Trips made on the Metropolitano involve in average 2.25 transfers while most trips in other forms of public transport usually involve 1 or 2 transfers, for an average of 1.36. While in both cases the poor make trips that involve higher numbers of transfers on average, the difference of almost twice between BRT and Non-BRT is a direct reflection of lack of integration of the system with other modes and the limitations of having single trunk line in operation.

**Figure 6. Poverty, cost of transportation, and the BRT**



Source: Nippon Koei CO 2013

### 3. Results in improving air quality

5.26 **Improving air quality –by reducing emissions of greenhouse gases and of fine particulate matter that affects health– was both a priority for Lima and a specific objective of the project.** Public transport accounted for about 75% of the emissions generated from mobile sources in Lima –a significant share, especially given that public

<sup>33</sup>

The poor are more likely to charge the cards with enough money for one or two trips, thus increasing their wait times and losing some of the time savings of having off-board fare collection with a smart card.



transport accounts for only 50% of total trips (emissions analysis). This disproportionate share of emissions was caused by an oversupply of small buses, a vehicle fleet of which 62% was older than 20 years, and low vehicle emission standards. Reducing air pollution along the corridor was one of the specific objectives of the project, with a goal of reducing emissions of fine particulate matter (PM 2.5) by 20%, and greenhouse gases (CO<sub>2</sub>) by 15%. From a corridor perspective, the targets set out in the loan documents had a high likelihood of being achieved since the project included both renewing the bus fleet and removing the old polluting buses from the corridor<sup>34</sup>.

- 5.27 **One of the key characteristics of the program in terms of improving air quality was replacing an old and inefficient bus system with new buses running on CNG, with emissions standards equivalent to EURO 4 and 5.** The Metropolitano was to improve efficiency by providing the same amount of service but traveling fewer than half the kilometers by using a hub-and-spoke configuration instead of point-to-point routes.<sup>35</sup> The buses were also designed to run on CNG instead of diesel, which in itself significantly reduces emissions of fine particulate matter.<sup>36</sup> In addition, the project included a program of scrapping 350 buses that was to be completed with GEF funding, and 1,253 buses were to be scrapped by the bus-operation concession winners. The grant helped develop environmental guidelines for implementing the vehicle scrapping program, guaranteeing proper dismantling and disposal of bus parts.<sup>37</sup> The project also included establishing three air quality monitoring stations along the corridor, although the information from these stations is not being used for measuring project results (emissions analysis).
- 5.28 **While the new system was implemented successfully and buses run on CNG, the complementary measures of scrapping the old buses and reducing the overall number of buses has not been fully accomplished, thus limiting the potential impacts of reducing emissions.** Completing the operation of the new system was a program in which each of the four bus-operating companies winning the concession would provide funds for removing and scrapping about 315 buses. These buses were initially thought to be the same ones operating along the corridor, but given the no-impact policy of not removing competing service, a contract amendment gave this responsibility to PROTRANSPORTE. The responsibility did not translate into authority, since each municipality's transport department licenses the operation of these buses and their

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Both IDB and World Bank project completion reports found improvements in corridor level ambient air quality and a 33% in GHG emissions (see annex Emissions Analysis).

<sup>35</sup> The number of km traveled by the traditional bus fleet was to be reduced to 222,000-343,000 km per day, while the new buses would provide about 117,000 km in total (including trunk and feeder buses) (emissions analysis). The hub-and-spoke system allows for large-capacity buses along the trunk line while using smaller buses as feeders, and maximizes the efficiency of the buses by increasing the number of passengers per vehicle and per kilometer travelled.

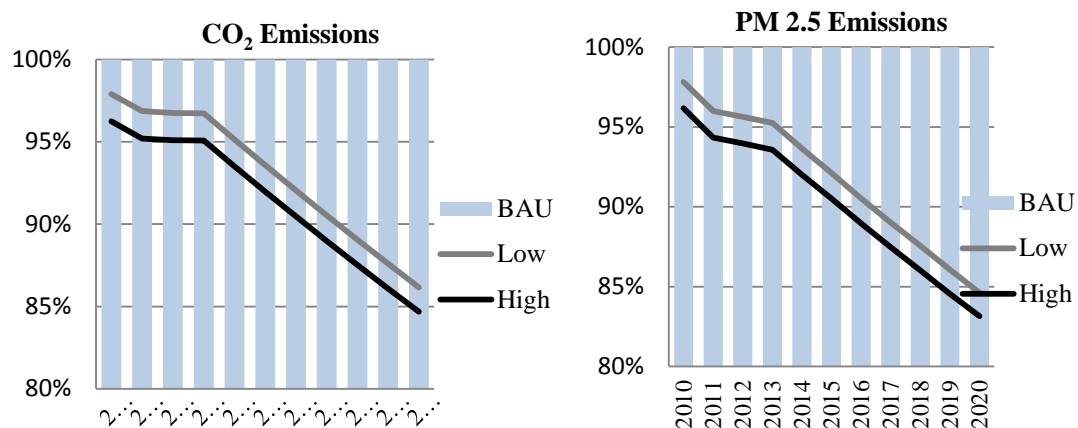
<sup>36</sup> Using CNG as fuel significantly reduces fine particulate matter emissions (0.6 tons/year compared to 14.1 tons/year for EURO II diesel buses), but in terms of CO<sub>2</sub> its impact is less noticeable (21,500 tons/year compared to 23,600 tons/year of EURO II diesel buses) (Grutter 2004).

<sup>37</sup> The scrapping is carried out in certified facilities, and the bus owners are paid after the bus is completely disposed of. The program includes paying the bus owner a competitive price once it is guaranteed that the vehicle or parts do not return to the public transport fleet.

operation continue without major restrictions. Recently Lima adopted a citywide program with a goal of scrapping 24,500 vehicles by 2020, including pickups, minibuses, and buses. PROTRANSPORTE has now scrapped 1,181 vehicles, mostly smaller buses, and the gradual upgrading of the public transport bus fleet seems to be under way.

- 5.29 **With El Metropolitano accounting for about 5.3% of daily public transport trips, the impact of the system on citywide emissions is marginal, but at a corridor level it could have significant effects on air quality.** Of all public transport trips in the city, the traditional bus service continues to provide 94%. Comparing the estimated effects of the system on emissions of fine particulate matter (PM 2.5) and carbon dioxide (CO<sub>2</sub>) with a business-as-usual scenario, the system reduces CO<sub>2</sub> emissions at a citywide level by between 2-6.5% in the first five years, and PM 2.5 emissions by 4-8% (see Figure 7). These estimations, calculated for the city as a whole, assume that no other changes happen to the public transport service, and show the potential of upgrading public transport and moving toward a more efficient system. At a corridor level, the improvement can be much more impressive. Per-passenger emissions of CO<sub>2</sub> were reduced by 72% from an average of 672 grams per year using the traditional bus system to 186 grams using the articulated buses of the Metropolitano. This change reflects the benefits of improving the bus technology and increasing the operational efficiency of the system, but it does not represent the project's net air pollution benefits to Lima, since most of the previously existing buses continued to operate or were displaced 500 meters from the corridor; it also does not capture potential increases in car ridership and the effects of ongoing road construction.

**Figure 7. Business-as-usual scenario (100%), and the projected emission reductions (citywide)**



Source: OVE, using emission reductions projections.

## D. Sustainability

- 5.30 **The city has been slow to implement complementary measures –improved station access and the 11 km extension to the north or the removal of conventional bus services from the BRT corridor– that would improve the overall performance of the system.** The extension to the north, although not part of the initial loan agreement, could easily have been built and ridership improved, if the government had approved it. The northern bus yard was relocated further north, and the articulated buses have been

covering the distance without any passengers; this cost is not recognized as part of the compensation structure to operators. The financial model was also based on a demand projection of 713,000 that included such extension (MACROCONSULT 2005), but with slow removal of competing service and the incomplete infrastructure, this level of demand has not been achieved after almost four years of service.

- 5.31 **The fare revenues have so far been insufficient to cover all the expenses of operating the system, and are still below the price bid by the private operators, putting pressure on the city, the operators, and the financing institution.** Since demand is below expectations, the fare revenues have been insufficient to cover all the expenses of operating the system, particularly the debt service for the buses. According to the bus operators, before the fare integration they were receiving only 56% of the price per kilometer they had bid, barely covering operation and administration expenses. After the fare integration this improved to 66%, fully covering the operation expenses but still insufficient to cover debt service. The city has already had to pay more than 90 million soles (US\$32.4 million at the June 2013 exchange rate) to cover the interest payments the bus operators were unable to afford. OVE estimates found that with current demand levels the operators are receiving 91% of the amount they initially bid per programmed kilometer (Table 2); however, the system has other areas to improve like the empty kilometers travelled and the lower than expected demand.

**Table 2. Fare revenues and the cost per kilometer**

Week	Programmed trunk kilometers	Programmed feeder kilometers	Average trunk km bid price	Average feeder km bid price	Payment to bus operators from fare revenue	% of bid price being received by operators
No. 23, 2013	393,448.85	339,832.28	S. 5.795	S. 4.125	S. 3,359,804.89	91%

Source: OVE, using administrative data from PROTRANSPORTE for a typical week in 2013, and similar ridership as of early 2014.

- 5.32 **The lack of a proper risk analysis and risk allocation strategy has meant that the contracts between the private operators and PROTRANSPORTE are not fully enforced, creating additional risks to the quality of the service provided by El Metropolitano.** The risk analysis carried out for the loan proposal focused on implementation and fiduciary risk and did not include an analysis of the full range of risks that the BRT system faced, including not meeting projected demand, or exchange rate fluctuations. Projected demand does not guarantee financial sustainability without proper mitigation strategies for the things that might go wrong. Moreover, failure to assign responsibilities and incentives to the actors with the appropriate tools to deal with them makes the system vulnerable. Unlike many other transport concessions, such as toll roads or metro systems, the project as designed did not include minimum revenue guarantees for the operators, and placed all the demand risk on them –a policy supported by the multilateral banks, which have been favoring full recovery of the operational cost for BRT systems. While this could have been a good deal for the city in a financial sense, the misplaced incentives ended up affecting the quality of the service and its sustainability. The city did not have the financial or political incentives to increase demand by removing competing bus service, and the operators had no way to increase their revenue except by reducing operation costs and not paying their debt obligations. Thus placing this risk solely on the operators affects the quality of service. The city

should bear a bigger share of this risk, since it is responsible for reorganizing the competition, building the infrastructure, and programming and promoting the service. To compensate for the missed demand forecast and after pressure from the operators, several of the contract clauses that were supposed to improve service quality –such as fines and liquidated damages– and requirements such as tow truck availability, are not being enforced. Particularly worrying is what could happen if the buses are not replaced after their service life ends and the debt is not paid off after 10 years, as initially designed.

- 5.33 **After completion of the project, changes in political priorities raised the risk of losing the gains achieved by the implementation and initial operation of the BRT system.** In January 2011, five months after the Metropolitano started revenue operations, a new mayor took charge of MML. Despite some initial promises to improve the operations of the Metropolitano and to extend the system, the new administration achieved little in this regard. Building new accesses to the stations, the need for which had become obvious after the first months of operation, took 3-4 years to materialize. The construction of a second BRT line, for which a feasibility study had been completed in 2010, was vetoed by the national Government because it overlapped with Metro Line 2, for which a rough concept had just been announced. Regrettably, the new city administration also failed to begin the 11-km extension of the Metropolitano to Chimpu Ocllo, which could have improved ridership and reduced the losses due to the kilometers travelled by the articulated buses without passengers. Many observers felt that the vision of a multi-line underground metro system, promoted by the national Government, became the main priority, leading to a certain neglect of the BRT system. As of December 2014, both IDB and the World Bank are fully supportive of the new metro lines that the national Government is planning to build, without a clear strategy for integrating with the bus service and at a cost that is many times higher than the BRT.

## VI. CONCLUSIONS

- 6.1 **The Metropolitano is by many measures a success, reinforcing the idea that a bus-based mass transit system can provide significant results for cities as big as Lima at a reasonable cost.** The project was relevant for the needs of the city, and provided a solution that was appropriate in terms of alignment, technology, and configuration. The Metropolitano achieved a gold mark in the BRT standards designed by ITDP, and it moves more than 590,000 passengers on a typical workday from the north and south cones of the city toward the financial district and the historical center of Lima. By using the BRT, passengers can reduce their travel time by an average of 34%, and per-passenger emissions of CO<sub>2</sub> are 72% lower. The line was placed in the highest-demand corridor, and although initially conceived as part of a network of BRT lines, it is in itself a strong stand-alone transport corridor. The project has created value for the city, including a new civic culture among users of the system, and has demonstrated the benefits of BRT systems as a mass transit solution for Lima.
- 6.2 **That said, urban transport projects should be regarded as more than transport-only projects. While the project was a success in terms of volume, speed, and time savings, and gives credibility to future urban transport efforts, the goals of**

**increasing local mobility and of being an urban development project that enabled denser development and encouraged non-motorized transportation were not fully realized.** Although urban transportation projects usually have as main goals to move as many people as possible in the most efficient and direct way; they can also offer the opportunity to transform other aspects of the built environment, like the redevelopment that occurred in the civic center of Lima, in part thanks to the underground Estacion Central. Links with land-use, urban development, accessibility, mobility, open spaces, and environment and health should be made more explicit when designing such projects, and they should include wider public participation to improve the urban design around the stations and neighborhoods.

- 6.3 **While the loans from IDB and World Bank were geared toward infrastructure investments, other aspects of the BRT required detailed attention and support.** BRT projects have three important components: the infrastructure (segregated busway and stations), the institutional framework (transport planning), and the operations (public-private partnership with private bus operators). The fact that the loans are geared toward infrastructure investments should not limit IDB's role in making sure that the investments are successful and sustainable. Moreover, not supporting localities with the operations, definition of contracts, and the optimization of the system might threaten the financial and technical sustainability of the system and the quality of service offered to the population. It is important that such loans, although with sovereign guarantee, include both in-depth private sector analysis and a review of the institutional framework under which the system would operate so that it can be integrated with existing and future transport alternatives.
- 6.4 **The risk analysis done by IDB covered only the fiduciary risks faced by the Bank and the municipality's ability to repay the loan, without also covering potential challenges for the BRT system that can affect its effectiveness and sustainability.** Allocating risk and incentives to the parties most qualified to mitigate them is the most powerful tool of a public-private partnership, and it is a key aspect to consider for the success and sustainability of the investment. By focusing on fiduciary risks, the project ended up with misplaced incentives that hindered the results. For example, the operators bear the demand risk, and their response is cutting costs and service quality because improving demand is beyond their control. At the same time, the city did not have many incentives to act quickly in removing the competing services, revising the fare structure, or building the extension to the trunk line that would connect the bus yard. There are many contract schemes that can make the bus operators accountable even though they don't assume the demand risk, including quality-based contracts that put strong emphasis on the quality of the service.
- 6.5 **IDB should question the policy of having BRT systems that cover operational expenses from fare revenues as the number one priority, above other competing objectives like providing transport service for the poorest of the poor, and should instead promote having a clear strategy for prioritizing among objectives.** While having multiple objectives is important, projects must recognize trade-offs and offer a strategy for dealing with them. Lower fares can attract more users and benefit lower- and middle-income families, but they put the financial stability of the system at risk. More

passengers per bus can reduce per-passenger air pollution, but this could mean overcrowded buses that do not offer the best service. An appropriate analysis of the trade-offs should be reflected in the design of both the infrastructure and the operational model of the system, and could include finding alternative funding sources to cover the system's operating costs—for example, capturing the value the transport investment creates by increasing property values around the terminals.

- 6.6 **Finally, changes in political priorities could jeopardize the achievements made by the Metropolitano project.** The city has been slow in improving the BRT system, while the national Government has been advancing the idea that an underground metro will be the solution for Lima's mobility needs. Plans for expanding the Metropolitano into a full-scale BRT system have been replaced by plans for a multi-billion dollar Metro Line 2, currently being supported by both the IDB and the World Bank. Metro Line 1, already completed in 2014 by the city, is not integrated with the BRT, physically, operationally, or in terms of fare and payment mechanisms. IDB should use its influence to promote integration between the two projects and foster elements that were also attempted under the Metropolitano, such as stronger and well-coordinated transport planning organizations for Lima as a whole, effective integration of mass transit services among the new systems and with standard bus services, and better land-use/transport integration.

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### Role of the IDB and other Stakeholders

	IDB	National Govt	Local Govt	Private Sector	Other MDB
<b>Planning and Diagnosis Phase</b>					
<i>Feasibility Studies (Loan Doc)</i>	D, F		D, F		WB (D, F)
<i>Risk analysis (Loan Document)</i>	Incomplete				WB (Incomplete)
<i>Institutional Strengthening activities (PCRs) No changes in framework.</i>	D		D, F, O		WB (D, F)
<i>Negotiation with the bus operators</i>			D, O		
<i>Alternatives Analysis (if done) or where did the project originate from.. (TCs)</i>	D, F <sup>1</sup>		D, F, O		WB
<b>Construction</b>					
<i>BRT Physical Infrastructure</i>	D, F, FP		D, F, C, M		WB (D, F, FP)
<i>Other infra (pedestrian-bikes)</i>	D, F		D, C		WB (D, F, FP)
<i>Resettlement – Compensation activities (PCRs: reallocated to construction and postponed by city)</i>	Some activities		D, F, O		
<i>Communication – Branding</i>			D, O		
<i>Public consultation: mainly WB.</i>	Some activities		D, F, O		WB (F, O)
<b>Reform of the Bus Sector</b>					
<i>Creation of a consortium or supervising entity</i>	D, F		D, F, O		WB (D, F)
<i>Creation of an integrated fare</i>	D, F		D, O		WB (D, F)
<i>Fare card system (TCs)</i>	D, F, FP		P, FP		
<i>Scrapping process (reallocated) PCRs</i>			D, F, O	O	
<b>PPPs</b>					
<i>Contract design/competitive bidding for bus companies – new business model (PCR)</i>			D, O		WB (D)
<b>Fare policy (Interviews)</b>			D, O	D, O	
<b>Sustainability</b>					
<i>2<sup>nd</sup> phase proposed for the project</i>			D, F, C, M		
<i>Other initiatives</i>		D, F, C <sup>2</sup>	D, F, O		

<sup>1</sup> Fuel technology analysis. It was decided that the BRT was the only feasible option. Metro was too expensive for the city at the time of design.

<sup>2</sup> A Metro is being built instead of the 2<sup>nd</sup> phase of the BRT, with support from IDB and WB.

**BRT Standard 2014 Scoring Sheet**

Item	Max. Score	Lima Score	Comments
<b>Segregated Right-of-Way</b>	<b>8</b>	<b>8</b>	Full segregation has been applied to 100% of the busways, in most cases by raised curbs. There is no doubt which constitutes the reserved busway. No pavement colorization has been used.
<b>Bus lanes in central verge of road</b>	<b>8</b>	<b>7.8</b>	<p>All busways are in the center of the roads, except for two sections where 2-way busways are located next to sidewalks of one-way roads</p> <ul style="list-style-type: none"> <li>• Av. Bolognesi in Barranco (1.2 km)</li> <li>• Jr. Lampa - Jr. Cuzco - Av. Emancipación in the historic center (2.1 km)</li> </ul> <p>The calculation of this score is as follows: <math>(27\text{km}-3.2\text{km}) * 8 + 3.2\text{km} * 6</math> divided by 27 = 7.76</p>
<b>Off-Vehicle Fare Collection and Verification</b>	<b>8</b>	<b>8</b>	Turnstiles at each trunk-line station
<b>Intersection Treatments</b>	<b>7</b>	<b>6.3</b>	There are signalized left-turns of mixed traffic at 4 intersections (<10% of total), 2 in Barranco and 2 along Av. Tupac Amaru. All other left turns are prohibited.
<b>Platform-level Boarding</b>	<b>7</b>	<b>7</b>	All trunk stations have platform-level boarding and achieve a vehicle-to-platform gap of about 10 cm or less (front door).
<b>Multiple Routes Use same BRT Infrastructure</b>	<b>4</b>	<b>4</b>	<p>All-stop Services</p> <ul style="list-style-type: none"> <li>- A: Matellini - Emancipación - Plaza Castilla</li> <li>- B: Matellini - Ugarte - Naranjal</li> <li>- C: Estación Central - Emancipación - Naranjal</li> </ul> <p>Plus 6 express services (5 peak, 1 all-day)</p>
<b>Limited and Local-stop Services</b>	<b>3</b>	<b>3</b>	<p>Local-Stop Services A, B and C (see above)</p> <p>Express Services</p> <ol style="list-style-type: none"> <li>1. Matellini - Ugarte - Naranjal (weekday peak periods)</li> <li>2. Plaza de Flores - Ugarte - Naranjal (weekday peak periods)</li> <li>3. Plaza de Flores - Ugarte - Naranjal (weekday peak periods)</li> <li>4. Plaza de Flores - Ugarte - Naranjal (Saturdays all day)</li> <li>5. Plaza de Flores - Ugarte - Naranjal (Weekdays all day)</li> <li>6. Super Express Plaza de Flores-Ugarte-Naranjal (Weekday peak)</li> </ol>
<b>System Control Center</b>	<b>3</b>	<b>3</b>	GPS monitors the location of buses and detects incidents in real-time.
<b>Routes in top 10 demand corridors</b>	<b>2</b>	<b>2</b>	Tupac Amaru and Via Expresa are among the 10 most busy corridors in Lima. The only other corridors where demand exceeds both BRT corridors are Panamericana Norte and possibly Javier Prado.
<b>Demand Profile</b>	<b>3</b>	<b>3</b>	All trunk corridor sections are Tier 1 configuration
<b>Operates late nights and weekends</b>	<b>2</b>	<b>2</b>	Weekday operation goes from 5 AM until 11 PM. There are weekend services on all corridors.
<b>Part of (planned) multi-corridor network</b>	<b>2</b>	<b>0</b>	There were plans to build a second BRT line, but these were blocked by the national Government, in favor of Metro line 2

Item	Max. Score	Lima Score	Comments
<b>Physically Separated Passing Lanes at Stations</b>	<b>4</b>	<b>4</b>	Segregated passing lanes exist at all 38 stations and terminals, except at 7 stations in Barranco and the historical center. In other words, 84% of all stations have passing lanes.
<b>Emission Standards</b>	<b>3</b>	<b>2</b>	Buses are Euro IV (as had been specified) and Euro V (one or two of the operators). Most importantly, they run on CNG and thus emit minimal amounts of PM.
<b>Stations set back from intersections</b>	<b>3</b>	<b>2</b>	Most stations are either on a vertically segregated road or set back sufficiently for a bus to advance to the (red) traffic light while the subsequent bus can load/unload at the gate. However, at least 10 cases were observed where the set-back is not sufficient, even though it could have been achieved.
<b>Stations are in Center and Shared by both directions of service</b>	<b>2</b>	<b>2</b>	Of the 35 stations (not including the terminals), 11 stations on the Vía Expresa are off-set from each other, although it is possible to walk from the inbound to the outbound platforms. In addition, 2 stations on Av. Emancipación are off-set, without pedestrian cross connections. The other 22 stations (63%) are in center and shared.
<b>Pavement quality.</b>	<b>2</b>	<b>2</b>	100% of busway pavement has been designed for 30 year life with reinforced concrete. After 4 years of operation, the pavement is in excellent condition.
<b>Distances between stations too long or too short</b>	<b>2</b>	<b>2</b>	Average station spacing is 750 m.
<b>Safe, wide, attractive weather protected stations</b>	<b>3</b>	<b>3</b>	All stations are at least 3.2 m wide and are weather protected, with the following exception: One station in Barranco and three in the city center received special design treatment to comply with requirements of the National Culture Institute. Although they do not include roof structures, no points have been deducted because (a) it never rains in Lima and (b) the resulting design is aesthetically more pleasing than the standard station design.
<b>3+ doors on articulated buses or 2+ very wide doors on standard buses</b>	<b>3</b>	<b>3</b>	All articulated buses have two doors in the rear section and one double-width door in the front section, all on the left side of the bus. In addition, they have two step-down doors on the right side of the bus, which are disabled in regular trunk-line operation.
<b>Multiple docking bays and sub-stops</b>	<b>1</b>	<b>1</b>	All stations with a passing lane have at least two independent sub-stops in each direction. Most stations without passing lanes have at least two docking bays in each direction.
<b>Sliding doors at BRT stations</b>	<b>1</b>	<b>1</b>	Yes, always
<b>Branding of vehicles and system</b>	<b>3</b>	<b>3</b>	All buses are have identical sleek designs, even though they are operated by 4 different bus operating companies. All stations carry they same “Metropolitano” insignia as the buses.
<b>Passenger information</b>	<b>2</b>	<b>2</b>	Real-time passenger information exists in all stations and buses.
<b>Universal Access</b>	<b>3</b>	<b>3</b>	All stations and buses are fully accessible
<b>Integration with other public transport</b>	<b>3</b>	<b>0</b>	There is no integration with conventional buses, nor with the recently completed metro line 1 (except for a low-grade feeder bus connection between Estación Central and Gamarra). Fare cards of metro line are not compatible with those of BRT.
<b>Improved safe and attractive pedestrian access to system and along corridor</b>	<b>3</b>	<b>2</b>	42% of the stations have grade-separated passenger access. All other stations have at least one well-lit crosswalk with curb cuts. Walking conditions within 500 m radius are often quite poor.
<b>Secure bicycle parking at stations.</b>	<b>2</b>	<b>1</b>	Secure bicycle parking is provided inside the two transfer terminal stations.

Item	Max. Score	Lima Score	Comments
<b>Bicycle lanes in corridor or on parallel streets</b>	<b>2</b>	<b>1</b>	There is a bikeway on Avenida Arequipa which parallels the BRT, at a distance of 0.3 km to 1.3 km, between the Estadio Nacional and Ricardo Palma stations
<b>Bicycle sharing</b>	<b>1</b>	<b>0</b>	There is no bike sharing near BRT.
<b>PENALTIES:</b>			
<b>Minimum average commercial speed below 13 km/h</b>	<b>-10</b>	<b>0</b>	Average commercial speed is 20 km/h for local services, and much higher for express services
<b>Peak passengers per hour per direction (pphpd) below 1000</b>	<b>-5</b>	<b>0</b>	Protransporte reports a peak hour volume of 32,000 pphpd in the most heavily traveled sections (between Caquetá and Castilla stations, and between Estacion Central and Canaval y Moreira)
<b>Lack of enforcement of Right-of-Way</b>	<b>-5</b>	<b>0</b>	No problems were observed
<b>Significant gap between bus floor and station platform</b>	<b>-5</b>	<b>0</b>	Bus docking is generally very good
<b>Overcrowding</b>	<b>-5</b>	<b>-1</b>	Severe overcrowding was not observed during peak hours – a great improvement since 2011. On weekends and off-peak hours, however, several instances were observed in which passengers could not enter the bus because it was full. This was confirmed by staff of Protransporte who acknowledged that the number of off-peak buses was being restricted to keep the IPK up. Really a bad practice!
<b>Poorly maintained buses and stations</b>	<b>-10</b>	<b>0</b>	No problems were observed
<b>Peak Period Frequency</b>	<b>-3</b>	<b>0</b>	
<b>Off-Peak Frequency</b>	<b>-2</b>	<b>0</b>	
<b>TOTAL</b>	<b>100</b>	<b>87.1</b>	<b>GOLD</b>

Notes: Scoring sheet was prepared by and provided to the team as one input to the case study by Gerhard Menckhoff, BRT Scoring Sheet, Lima Aug, 2014.