ove Office of Evaluation and Oversight

Approach Paper

An Evaluation of the Effects of IDB Supported BRT Systems on Mobility and Access for the Poor in Cali and Lima

IDB

Inter-American Development Bank

March 2016

© Inter-American Development Bank, 2016
Office of Evaluation and Oversight
1350 New York Avenue, N.W.
Washington, D.C. 20577
www.iadb.org/evaluation

RE-497

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

BRT	Bus rapid transit
CBD	Central Business District
IDB	Inter-American Development Bank
LAC	Latin America and the Caribbean
PTUL	Lima Urban Transportation Program
OVE	Office of Evaluation and Oversight

I. INTRODUCTION

1.1 Bus rapid transit (BRT) systems have become an increasingly popular approach to addressing mobility and environmental problems in urban areas in Latin America and around the world. In line with this trend, the IDB's support for BRT projects as well as other urban transport in Latin America and the Caribbean has grown rapidly in recent years: the annual lending volume for the urban transport sector grew by 36% from 2005 to 2012, to account for more than 20% of the transport sector lending portfolio. BRT systems represented roughly half of all IDB mass transit projects. These projects typically aim to increase overall mobility while also reducing negative externalities such as traffic accidents and emissions of local and global pollutants; in addition, they often seek to improve mobility and access to jobs, goods, and services for the poor. A recent OVE evaluation (RE-454-1) of bus rapid transit systems presented lessons learned from three IDB-funded BRT projects –in Lima, Cali, and Montevideo. Although the projects (Cali and Lima) achieved considerable *in-vehicle* travel time savings and environmental benefits (in the form of reduced vehicle emissions), the benefits to the poor living in the area of influence of the systems were lower than expected.

1.2 Building on OVE's recent evaluation, this analysis of BRT Systems and Poverty in Cali and Lima aims to expand the aforementioned evaluation of the BRT project results with respect to their objectives of improving mobility and access for the poor. Specifically, the evaluation will seek to identify determinants of and barriers to BRT use among the poor in Lima and Cali. Furthermore, it also seeks to identify spatial and pricing mismatches between the poor and the BRT system. In particular, the analysis will assess the relative role of access times, in-vehicle time and monetary costs in explaining the mobility preferences, in order to improve the design and operation of future BRT systems with pro-poor objectives.

II. BACKGROUND

2.1 Disparities in the costs and access to transportation systems contribute to and reinforce the already high levels of inequality in LAC. Low-income populations often bear the highest burdens related to negative transport externalities in cities, including longer travel times and higher exposure to pollution and risk of traffic accidents. Lack of access to affordable and efficient transport generates social exclusion, impeding access to employment opportunities, services, and markets. Poor populations often live on the periphery of cities and must travel long distances to reach jobs and services in the center; thus they tend to have the longest travel times and incur more transfers (Ardila-Gomez, 2012). While they incur long travel times to the central business districts (CBD) many take trips to more dispersed locations outside of the CBD.

2.2 The impacts of urbanization on public transportation hold particular salience for Latin America, the world's most urbanized region. From 1950 to 2014, the percent of the population in Latin America living in urban areas increased from 40% to around 80%, and this figure is expected to increase to 90% by 2050 (Atlantic Council, 2014). Increased demand for housing associated with rapid

urban growth commonly leads to increases in the value of centrally-located city land, thereby pushing lower-income groups outward to the periphery of urban areas. This change, in combination with increased motorization rates, congestion, over-supply and informality in the public transit sector has led to a decrease in the quality of public transportation for many of these urban spaces (Carruthers, Dick, and Saurker, 2005).

2.3 In the last two decades, most Latin American cities have increased investments in public transport systems. Improving urban mobility has become a central concern of regional development as urban population and incomes increased significantly and therefore motorization rates grew steadily. Urban expansion and poor planning have contributed to congestion and longer commuting journeys, to segregation, inequity and fragmentation; and thus have isolated low income populations from the opportunities provided by the city.

2.4 Lima and Cali are part of a growing number of Latin American cities that have invested in BRT systems in order to improve public transport quality. The cities are characterized by a high degree of urban socioeconomic segregation and inequality. In terms of urban mobility, low income populations in Cali and Lima tend to live in peripheral zones, have longer journeys to access main activities, which present issues of limited affordability and access. The BRT systems in both cities were supported by loans from the IDB and aimed at improving efficiency of local mobility, decreasing environmental impacts and reducing transport-related social inequalities (see Table 2.1).

Table 2.1 Overview of the two IDB-supported BRT projects

	Lima	Cali
Project Details	PE-L0187	CO-L1001
Project name	*Lima Urban Transport Program*	*Cali: Integrated Mass Transit System*
Approval year (completion)	2003 (2010)	2005 (2014)
Main Objectives	-Improve mobility, public transport, and urban environment - Mobility for the poor - Reduce accidents & emissions	- Improve mobility, public transport, and urban environment -Mobility for the poor - Reduce accidents & emissions
Number of trunk lines	1 (28km)	3 (49km)
Expected demand (pass./day)	600,000	850,000
Planned IDB contribution	US$45 million	US$200 million
Total planned cost	US$124 million	US$300 million

Source: IDB Loan Documents PE-L0187 and CO-L1001

2.5 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. 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. The main objective of the project 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. For this purpose, the program will establish a transportation system that is efficient, modern, reliable and safe, based on large-capacity buses circulating on dedicated bus lanes. This will make places of employment and economic and social services more accessible, mainly for the poorest population groups; it will also shorten travel time, reduce the number of accidents involving public transportation, and lessen environmental pollution." (IDB, Loan Document PE187).

2.6 The project is included in the Lima Urban Transportation Program (PTUL) supported by IDB. According to the project description it would serve an area of around 3.5 million inhabitants, 60% [400,000] of whom are low income.

2.7 In 2002, the Colombian Government developed a National Program for Urban Transport to develop integrated public transport systems in several cities, seeking financial support from the multilateral development banks. Following the experience of Bogotá's *Transmilenio*, it decided to implement BRT-oriented integrated mass transit systems in the country's seven largest cities after Bogotá: Barranquilla, Bucaramanga, Cartagena, Pereira, Santiago de Cali, Medellin, and Soacha.[1] IDB participated in the Cali BRT project through two loans, 1659/OC-CO and CO-L1101. The project was part of a national initiative aimed at providing Colombian major cities with BRT systems. The main objective of the Cali BRT project was:

> "…to improve the transportation options of the population of the city of Cali, in particular low-income segments. The Cali IMTS has and will continue to improve service quality, reducing travel time, accidents, and pollution of the environment, and increasing service frequency and reliability. *In particular, with the implementation of a modern bus transport system that will connect the low- and middle-income areas of Cali with the areas where job-generating activities and social services are concentrated, the IMTS will benefit primarily the lowest socioeconomic segments in strata 1 to 3* (low-low to medium-low), which account for 85% of the system's users, and the Afro-descendent population, which represents 26% of Cali's urban population." (IDB, Loan Document L1101).

[1] The Colombian Government assigned the project in the largest city to the IDB, and the projects in the other six mid-sized cities to the World Bank.

III. OBJECTIVES AND SCOPE

3.1 The objective of the evaluation is to assess the effects of Cali's and Lima's BRT systems on mobility and accessibility of the poor, with a specific focus on the integration of feeder lines in the poor areas of the cities. Specifically, the evaluation will seek to answer the following questions:

1. *Planning:* How well were poverty issues included in the BRT system planning process and considered in monitoring and evaluation framework of the system?
2. *BRT coverage:* How well did the BRT systems provide coverage to low-income/poor areas and to what extent were the systems service features (schedules, frequencies, routes) well matched to the travel demand patterns of the poor?
3. *BRT system perceptions and usage:* What are the perceptions of the BRT services among the poor living within the area of influence of the system? What are the barriers to usage? What are the rates of usage compared to other public transit modes and compared to project objectives among the poor public transit users living within the area of influence of the systems?
4. *Affordability, tariff policies, and subsidies*: How do tariffs of the BRT system compare to other available public transit modes and to income, and to what extent are affordability issues a concern[2]? How are tariff policies determined in the cities and to what extent do these policies take into account the project's poverty objectives? What are the tradeoffs between mobility, financial sustainability, and environmental objectives in determining the tariffs and/or subsidies (whether such subsidies are explicit or implicit)?
5. *BRT versus other public transit mode usage determinants:* Among the poor who use the system, what are characteristics of the users and the bus services, or trip types compared to those using alternative public transit modes? How can the identified determinants of BRT usage be utilized to inform BRT feeder and system design generally?
6. *BRT System and feeder integration design for social inclusion:* Going forward, how can the cities better integrate the informal public transport sector to the formal transit sector, in a way that increases mobility and access for the poor? How can the findings of the analysis inform future IDB investments in public transport that seek to include the poor in the benefits of the project?

IV. METHODOLOGY

4.1 To answer the questions outlined above, the team will utilize a combination of qualitative and quantitative methods including 1) best practices research of BRT/informal transport integration in other urban areas globally, 2) a literature review on policy approaches in Latin America to increase public transit tariff

[2] Affordability to be defined in the literature review. The team will use survey collected on public transit expenditures and income to answer the question relative to international definitions of transportation affordability in the literature. The team will also analyze survey responses on people's perception of the system affordability compared to other modes.

affordability 3) interviews with stakeholders in Lima and Cali and help gather any additional data needed for analysis including bus route designs (frequencies and locations) before and after the BRT in poor areas within the area of influence of the BRT feeder lines, 4) analysis of survey data to understand the determinants of BRT use by poor populations, and 5) geostatistical spatial analyses using available data on BRT route service and travel patterns of populations living in the area of influence of the BRT systems to quantify the extent of BRT system (trunklines and feeders) service coverage to the poor (defined as Strata E & D in Lima and Strata 1 and 2 in Cali).

4.2 The team will utilize existing city origin destination surveys (OD)[3] collected by the team in prior missions and survey data collected by OVE in 2014 on low-income/poor public transit users who live within the area of influence (defined as walking distance) of the systems (*See Methods Annex for more information on the evaluation methodology)*.

4.3 The team will conduct stakeholder interviews with relevant government officials and experts, and by comparing the systems in Lima and Cali to best practices in other urban areas globally.

V. TEAM AND TIMELINE

5.1 The report will be prepared by a team led by Lynn Scholl under the direction of Cheryl Gray (Director, OVE). The team will include Cesar Bouillon (Principal Economist), Daniel Oviedo (consultant), and Lisa Corsetto (consultant).

5.2 The report is expected to be completed and submitted to the Board of Executive Directors in April 2016.

[3] The team has collected OD data for both cities on prior missions.

REFERENCES

Atlantic Council (2014) 'Urbanization in Latin America,' Document of the Adrienne Arsht Latin America Center, Washington, D.C.

Bocarejo, J. and Oviedo, D. (2012) 'Transport accessibility and social inequities: a tool for identification of mobility needs and evaluation of transport investments,' Journal of Transport Geography, Article in Press, Corrected Proof.

Carruthers, R., Dick, M., and Saurkar, A. (2005) 'Affordability of Public Transport in Developing Countries,' Document of the World Bank, Washington, D.C.

Cervero, R. and Golub, A. (2007) 'Informal Transport: A Global Perspective,' Journal of the World Conference on Transport Research Society: 445-457.

Golub, Aaron (date unknown) 'Regulating Small-Scale Transit Operators,' University of California Transportation Center, Berkeley, California.

IDB (2015) 'Comparative Case Studies of Three IDB-Supported Urban Transport Projects,' Document of the Inter-American Development Bank, Washington, D.C.

IDB (2015b) 'Comparative Case Studies, IDB Supported Urban Transport Projects: Annex' Document of the Inter-American Development Bank, Washington, D.C.

Levinson, H., Zimmerman, S., Clinger, J., Rutherford, S., Smith, R.L., Cracknell, J. et al. (2003) 'Bus Rapid Transit: Case Studies in Bus Rapid Transit, Vol 1,' TCRP Report 90, Transportation Research Board of the National Academies: Washington, D.C.

Mitric, S. and Carruters, R. (2005) 'The Concept of Affordability of Urban Public Transport Services for Low-Income Passengers,' Document of the World Bank, Washington, D.C.

Rodriguez, D. and Vergel Tovar, E. (2013) 'Bus Rapid Transit and Urban Development in Latin America, Land Lines,' Lincoln Institute of Land Policy, January 2013, 14-20.

Wright, L. and Hook, W. (2007) 'Bus Rapid Transit Planning Guide' Institute for Transportation and Development Policy, New York.

ANNEX I: METHODOLOGY

Q1. Planning: *How well were poverty issues included in the BRT system planning process and considered in monitoring and evaluation framework of the system?*

Methods will include interviews with relevant stakeholders in the cities including urban and transport planners, bus users, bus operators, and officials in the ministry of Housing and Urbanization and the Ministry of Transport and review of project planning documents.

Q2. BRT coverage spatial coverage*: How well did the BRT systems provide coverage to low-income/poor areas and to what extent were the systems service features (schedules, frequencies, routes) well matched to the travel demand patterns of the poor?*

Methods will include geostatistical spatial analyses using data of BRT route service (routes and frequencies, using available data) and OD patterns of poor public transit to quantify the extent of BRT system (trunklines and feeders) service coverage to the poor (defined as Strata E & D in Lima and Strata 1 and 2 in Cali) in Cali and Lima. Prior OVE analysis provided a visual mapping of the location of poor relative to the BRT systems' trunk and feeder lines, however, no analysis of the share of poor and low income that within walking distance of bus line was conducted. The evaluation will use spatial data gathered from two origin destination (OD) surveys to generate coverage indices. The evaluation will utilize the average walk time data to construct a heat map that identifies key *access gaps of the BRT system currently.*

Data will include geo-coded population by socio-economic strata, Origin-Destination Surveys, BRT system routes.

Q3. BRT system perceptions and usage: *What are the perceptions of the BRT services among the poor living within the area of influence of the system? What are the barriers to usage? What are the barriers to usage? What are the rates of usage compared to other public transit modes and compared to project objectives among the poor public transit users living within the area of influence of the systems?*

Methods will include analysis of mobility and user preference surveys. The data from available mobility surveys will be complemented with surveys financed by the IDB Office of Evaluation and Oversight (OVE). From June 4th to 10th the team conducted a revealed and stated preferences survey in the city of Cali with the purpose of identifying detailed travel practices of public transport users living in poverty, their preferences in relation to travel expenditure and their valuation of general attributes of public transport modes, particularly the local BRT, MIO. The sample was gathered in close proximity to the corridors of the Bus Rapid transit in areas where conditions of low income were previously identified. The survey sampled 797 users of different types of public transport categorizing some of their main socioeconomic and transport-related variables. The selection of the sample was designed to identify the 'Poor' and 'Very Poor' according to the socioeconomic stratification of the city and other methodologies for distribution of social welfare as Colombia's SISBEN. The sample exhibits similar socioeconomic characteristics to those observed for low-income groups in previous studies like the Origin-Destination survey of the city (2010) and the Life quality survey of the same year. The sampling technique used the socioeconomic stratum of the interviewee as a central filter in order to capture effects only on interviewees of strata 1 and 2, commonly related to low-income populations.

Between October and November 2014 a revealed and stated preferences survey was conducted in the city of Lima to determine the travel practices of low-income PT users, their perceptions of public transport services and their valuation of general attributes of public transport modes. The survey was administered to 837 potential public transit users who were from the lowest income strata (E and D) and the lower middle income stratum (C) intercepted within 1km of the BRT trunk and/or feeder lines. The sampling technique in Lima included filter questions related to NSE and control questions that allowed to calculate a 'poverty-score' based on the NSE methodology (APEIN, 2014). The survey instrument included questions about the number of days in the last week respondents left home to conduct a given activity.

This data will be utilized to generate descriptive statistics, including means tests, of travel characteristics of poor and non-poor and users and non-users of the BRT systems, perceptions/opinions of poor populations living in the area of influence of the system, stated reasons for not using the system among other variables.

Q4. Affordability**:** *How do tariffs of the BRT system compare to other available public transit modes, to income, and to what extent are affordability issues a concern[1]? How are tariff policies determined in the cities and to what extent do these policies take into account the project's poverty objectives? What are the tradeoffs between mobility, financial sustainability, and environmental objectives in determining the tariffs and/or subsidies (whether such subsidies are explicit or implicit)?*

Methods will include a literature review on policy approaches in Latin America to increase public transit tariff affordability. The team will use survey collected on public transit expenditures and income to answer the question relative to international definitions of transportation affordability in the literature. The team will also analyze survey responses surrounding people's perception of the system affordability compared to other modes.

Q5. BRT versus other public transit mode usage determinants: *Among the poor who use the system, what are characteristics of the users and the bus services, or trip types compared to those using alternative public transit modes? How can the identified determinants of BRT usage be utilized to inform BRT feeder and system design generally?*

Methods will include analysis of users' survey data and preferences data. In addition to asking about trips taken the prior day ("revealed preference"), OVE's survey respondents were presented with a randomized group of choices of hypothetical means of travel ("stated preference"). The respondent stated and revealed choices will provide the data for the estimation of discrete choice models. Each of the hypothetical stated preference alternatives is described by their characteristics (i.e. access time, which includes both walking and waiting time, cost, and travel time) and the respondent is asked to choose their preferred alternative based on such attributes. An example choice set is presented in Figure I.1. Option 1 would be a representation of MIO system, option 2 Individual or Collective Taxi and Option 3 Traditional Public Transport.

[1] Affordability to be defined in the literature review. The team will use survey collected on public transit expenditures and income to answer the question relative to international definitions of transportation affordability in the literature. The team will also analyze survey responses on people's perception of the system affordability compared to other modes.

Figure I.1. Sample choice set-Cali

FICHA 1	OPCIÓN 1		OPCIÓN 2		OPCIÓN 3	
						
	10	Minutos	5	Minutos	10	Minutos
	30	Minutos	40	Minutos	25	Minutos
	1000	Pesos	1500	Pesos	2500	Pesos

Source: OVE's survey

In OVE's survey each interviewee was presented four choice sets. With this information we calibrate a series of discrete choice models that allow us to identify the relevance of different travel attributes for the poor. These are compared to travel characteristics of the MIO for evaluation purposes and can also serve as basis for design of interventions targeting the most critical travel variables for the poor in Cali. In Lima's survey instrument, a series of alternatives described by three main attributes: access time, in-vehicle time, and costs in Nuevos Soles for the fare. An example choice set is presented in Figure I.2 where option 1 would be a representation of the Metropolitano system, option 2 traditional public transport and option 3 rail.

Figure I.2. Sample choice set-Lima

FICHA 1	OPCIÓN 1		OPCIÓN 2		OPCIÓN 3	
						
	10	Minutos	5	Minutos	10	Minutos
	30	Minutos	40	Minutos	25	Minutos
	1.5	Soles	2	Soles	3	Soles

Source: OVE's survey

The basic model reflects the effect that variables as time and cost have for the studied population in the maximization of the utility of using a given public transport alternative. It is hypothesized that in the case of low-income population a lower coefficient would be expected for travel times while travel cost should explain most of the utility, V, of a given mode.

$$V_{Mode\,i} = \alpha_{Mode\,i} + \beta_{TT} TT_{Mode\,i} + \beta_{AT} AT_{Mode\,i} + \beta_C C_{Mode\,i}$$

Where:

$V_{Mode\ i} = Individual\ utility\ of\ Mode\ i$

$\beta_{TT} = Travel\ time\ coefficient$

$TT_{Mode\ i} = Travel\ time\ for\ Mode\ i$

$\beta_{AT} = Access\ time\ coefficient$

$AT_{Mode\ i} = Access\ time\ for\ Mode\ i$

$\beta_{C} = Cost\ coefficient$

$C_{Mode\ i} = Cost\ for\ Mode\ i$

$\alpha_{Mode\ i} = Mode\ constant\ for\ Mode\ i\ (0\ for\ the\ first\ mode)$

The results of the mobility preferences model estimation will help evaluate the relative contribution that access times, in-vehicle time and monetary costs have in explaining the mobility preferences, and thus play an important role in designing and operating them to maximize their positive impacts on low income households[2].

Similarly, the team will utilized the revealed preference survey data to evaluate the determinants of mode choices among the poor living near the system between the traditional and the BRT system in order to identify areas where the BRT system could be improved to better serve the needs of poor populations.

Data for this analysis includes OD surveys already collected by OVE and OVE's survey of low-income populations living in the area of influence of the BRT systems.

Q6. BRT System and feeder integration design: *Going forward, how can the cities and IDB better integrate the informal public transport sector to the formal transit sector, in order to increase mobility and access for the poor?* How can the findings of the analysis inform future IDB investments in public transport that seek to include the poor in the benefits of the project?

Methods will include best practices research of BRT/informal transport integration in other urban areas globally and interviews with subject matter experts and key stakeholders in the cities.

[2] The model specification does not assume differences in the coefficients of travel attributes for each of the modes. It rather attributes unobservable effects on the choice process through mode constants identified for choices one and three.