TC Document

I. Basic Information for TC

▪ Country/Region:	ECUADOR
▪ TC Name:	Comprendiendo los impactos de los sistemas de metro en ALC: El caso de la Primera Línea de Metro de Quito
▪ TC Number:	EC-T1584
▪ Team Leader/Members:	Calatayud, Agustina (INE/TSP) Líder del Equipo; Armijos Leray, Jean Pol (INE/TSP) Jefe Alterno del Equipo de Proyecto; Oscar Mitnik (SPD/SDV); Chauvin Rodriguez, Juan Pablo (RES/RES); Campos Lombeida, Liseth Antonella (INE/TSP); Jimenez Mosquera, Javier I. (LEG/SGO); Zanoni Lopez, Wladimir (CAN/CEC); Ferro Briceno Paula Vanessa (INE/TSP); Rivas Amiassorho, Maria Eugenia (INE/TSP); Laguado Giraldo, Roberto (VPC/FMP); Borja Plaza Leonel Alejandro (INE/TSP); Cardenas Garcia, Claudia Mylenna (VPC/FMP); Brito Vera, Juan Carlos (CAN/CEC); Scholl, Patricia Lynn (INE/TSP); Navas Duk, Cristian Lee (INE/TSP); Ramirez Pimiento German Daniel (INE/TSP); Paredes Calero Adriana Jacqueline (INE/TSP); Pedraza Sanchez, Lauramaria (INE/TSP); Quintero Escobar, Luis (SPD/SDV)
▪ Taxonomy:	Investigación y Difusión y Difusión
▪ Operation Supported by the TC:	
▪ Date of TC Abstract authorization:	3 Sep 2024.
▪ Beneficiary:	Empresa Pública Metropolitana Metro de Quito (EPMMQ)
▪ Executing Agency:	Inter-American Development Bank
▪ Donors providing funding:	OC SDP Ventanilla 2 - Infraestructura(W2B)
▪ IDB Funding Requested:	US$375,000.00
▪ Local counterpart funding, if any:	US$0
▪ Disbursement period (which includes Execution period):	36 months
▪ Required start date:	December 2024
▪ Consultant types:	Individual; Firms
▪ Prepared by Unit:	INE/TSP-Transporte
▪ Disbursement Responsible Unit (UDR):	CAN/CEC-Representación Ecuador/
▪ TC included in Country Strategy (y/n):	No
▪ TC included in CPD (y/n):	No
▪ Alignment to the Updated Institutional Strategy Transformation for Greater Scale and Impact (2024-2030):	Inclusión social e igualdad; Productividad e innovación; Sostenibilidad ambiental; Igualdad de género; Diversidad; Personas con discapacidad

II. Objectives and Justification of the TC

2.1. **Objective.** This Technical Cooperation aims to evaluate the impact of Quito's First Metro Line (PLMQ by its initials in Spanish) on mobility, environmental, and socioeconomic outcomes. By generating rigorous causal evidence, this TC seeks to enhance the understanding of how large-scale transportation systems create societal value, providing insights to inform future projects of a similar nature across Latin America and the Caribbean (LAC).

2.2. The specific objectives are: (i) to evaluate the PLMQ's direct effects on travel time, congestion, choice of transportation modes, greenhouse gas emissions, land uses, building density, and other mobility, environmental, and urban development outcomes; (ii) to examine how these impacts translate into opportunities for employment, educational access, and local economic activity.

2.3. **Justification.** The PLMQ is one of Ecuador's most important infrastructure projects and marks a significant advancement in Quito's public transportation system. In operation since December of 2023, the PLMQ's underground tunnel stretches approximately 22 kilometers, connecting the north and the south of the city and featuring 15 stations along the route.

2.4. The project was completed with a total investment of USD 2.1 billon. Its financing represented an unprecedented collaboration with several multilateral institutions. In 2012, the Inter-American Development Bank approved a USD 450 million loan, which had the operational closure date in December of 2021. The World Bank, the Development Bank of Latin America (CAF), and the European Investment Bank (EIB) provided the additional funding.

2.5. The PLMQ significantly reduces travel times for most of its users. For instance, it reduces the trip from Quitumbe in the south to Labrador in the north from one hour and 40 minutes to 34 minutes. Additionally, it is expected to reduce operational transportation costs, improve connectivity, safety, and the comfort of the current system, and decrease emissions of pollutants and Greenhouse Gases (GHG).

2.6. As the first metro line funded by the IDB and with a total cost of approximately 200% of Quito's 2022 executed city budget[1], the project offers a unique opportunity to examine the value created by large-scale transit infrastructure in the region and to weigh benefits against costs. Studying the impacts of Quito's first metro line is thus crucial for shaping future city and region mobility projects.

2.7. **Gender.** Women make more public transport trips than men[2] and are also frequent victims of harassment and other forms of violence while using public transportation. Their mobility patterns differ from men's, partly due to caregiving responsibilities and other gender-based roles, which place additional time constraints on their daily routines. By providing a safer, more reliable, and faster transit option, the PLMQ could improve access to education and employment for women, potentially addressing barriers that contribute, for instance, to Ecuador's gender gap in labor force participation, where only 53.2% of women are economically active compared to 77.9% of men in 2023[3]. This evaluation, therefore, will provide insights into the effects of large-scale transportation systems on various aspects of women's well-being.

2.8. **Diversity.** In Ecuador, there are 480,776 persons with disabilities, with 72,058 residing in Quito[4]. Among this population in Quito, the most common types of disabilities are physical (41.11%), followed by intellectual (22.50%), hearing (14.75%), visual (12.34%), and psychological (7.09%). Persons with disabilities (PwD) encounter both physical and attitudinal barriers in public transportation, not only in Ecuador but worldwide. According to a survey by the Global Alliance on Accessible Environments and Technologies (GAATES) across 39 countries, several critical challenges emerged for PwD. Specifically, 47% of respondents reported inaccessible public transport vehicles, 35% experienced negative attitudes from drivers and staff, and 26% noted a lack of public transportation options. These accessibility challenges also lead to financial strain.

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1 Municipal Goverment of Quito. Presupuesto Abierto. Accessed in October 2024.
2 Serebrisky, Suárez-Aleman and Rivas (2019). Stylized Urban Transportation Facts in Latin America and the Caribbean.
3 World Bank. Gender Data Portal: Ecuador. Accessed in October 2024.
4 CONADIS. Estadísticas de Discapacidad. Accessed in November 2024.

Due to limited accessible transportation and infrastructure, PwD often rely on taxis, incurring higher daily costs ranging from $1 to $16, with an average of $8 per trip[5]. The Metro of Quito has implemented various accessibility measures, including ramps, tactile pathways, audio systems, and elevators, to support inclusive transportation. To further enhance these efforts, it is worthwhile to collect trip information and conduct user satisfaction survey targeting persons with disabilities, segmented by disability type, to gather feedback and inform future improvements in accessibility and inclusion.

2.9. **Strategic Alignment.** This TC is consistent with the IDB Group's Institutional Strategy: *Transforming Scale and Impact* (CA-631) and aligns with the objectives of (i) reducing poverty and inequality, as the impact evaluation of the PLMQ assesses its potential to improve economic opportunities for low-income residents by significantly reducing commute times, thereby enhancing access to employment, education, and essential services. This improved access can help bridge socioeconomic gaps, contributing to poverty reduction and greater economic inclusion; (ii) addressing climate change, as the impact evaluation will assess the effect of the PLMQ on emissions. By encouraging a shift from private vehicles to a cleaner, electric-powered option, the PLMQ has the potential to reduce air pollution; and (iii) bolstering sustainable growth, as the evaluation supports the objective of sustainable growth by studying how a large-scale urban transportation system promotes productivity growth through agglomeration effects that may boost local economic activity.

2.10. The project also aligns with the following operational focus areas: (i) gender equality and inclusion of diverse population groups because the impact evaluation will be differentiated by gender and age; (ii) institutional capacity, rule of law, and citizen security, by building institutional capacities in EPMMQ to support the impact evaluation; (iii) productive development and innovation through the private sector, by financing studies to identify the impacts of the project, contributing to transport efficiency and implementing innovative solutions; and (iv) sustainable, resilient, and inclusive infrastructure, by measuring greenhouse gas emissions reductions from system operation.

2.11. It also aligns with the IDB Group's Strategy with Ecuador 2022-2025 (GN-3103-1) in the pillars of boosting productivity by promoting projects that improve local connectivity and reduce transportation costs and deepening social advances by incentivizing accessibility through mobility to the provision of quality public services. The TC is also aligned with the Ordinary Capital Strategic Development Program (OC SDP) - Window 2 (W2B) Sustainable Infrastructure (GN-2819-17), in the priority area of sustainable and resilient infrastructure.

2.12. This TC is a Bank-driven R&D initiative designed to generate knowledge on development effectiveness. In March 2024, the Vice Presidency for Sectors and Knowledge (VPS) and the Office of Strategic Planning and Development Effectiveness (SPD) launched the inaugural funding round for the Development Effectiveness Intelligence Fund (DE Intelligence Fund). The Knowledge Advisory Committee (KAC) reviewed numerous submissions and, in August 2024, selected 27 proposals for funding, including the Impact Evaluation of the PLMQ. This evaluation was prioritized based on its potential to contribute valuable insights into the socioeconomic, environmental, and mobility impacts of large-scale transportation systems in urban contexts. The direct beneficiaries of this TC are the Bank and other institutions involved in research and policymaking in the region. The final beneficiaries are the municipal government of Quito and Empresa Pública Metropolitana Metro de Quito (EPMMQ), as the evaluation will inform policy decisions that aim to maximize the positive impacts of the PLMQ and guide similar projects in other cities.

III. Research Questions and Empirical Strategies

3.1. The primary questions we seek to answer are how the PLMQ affects mobility, economic activity, pollution, school enrollment and attendance, labor force participation and job accessibility, land

[5] Diario La Hora. 2023

use, and urban development. Where possible, these questions will incorporate a gender component to examine differential impacts on men and women.

3.2. These inquiries build on a body of literature that shows that large-scale transit systems can reduce congestion[6][7], increase real estate value[8], and sometimes lower air pollution[9]. Such systems have also been shown to increase college enrollment[10] and connectivity from workers from remote areas[11], thereby reducing labor informality[12]. At the same time, this TC will contribute to the literature, examining the impact of implementing a whole new transit system in a middle-income country—a potentially more substantial intervention compared to the addition of subway lines to an existing network in high-income settings, which has been more frequently studied.

3.3. Estimating the causal impact of transport infrastructure requires addressing the non-random placement of these projects. Urban transportation projects like the PLMQ are typically designed to address specific challenges, such as pre-existing urban development needs, areas with higher anticipated demand, and regions facing socioeconomic disparities. These factors, which often determine where infrastructure is placed, are also closely tied to the outcomes we aim to study, such as mobility, economic activity, and land use. This overlap creates an endogeneity problem, as the placement of metro stations and the line itself is influenced by pre-existing conditions. As a result, areas targeted by the PLMQ may already differ systematically from those not targeted, in ways that could independently affect the outcomes. This complicates causal attribution, as observed effects might reflect these initial differences rather than the true impact of the PLMQ.

3.4. Endogeneity is outcome-specific so that different outcomes may require tailored empirical strategies. However, to estimate the impact on most of the outcomes we study, we rely on a difference-in-differences (DID) framework. While the specifics of the model may vary by outcome, the underlying intuition remains the same: we compare changes in trends between areas close to either the station or the line itself with areas farther from the PLMQ's influence before and after the areas were affected by the metro. Note that the timing that defines the "before" and "after" periods may also vary depending on the specific outcome being analyzed.

3.5. The main assumption that allows causal inference in DID models is the parallel trends assumption. In evaluating the PLMQ's impact, this assumption implies that, in the absence of the metro, differences in outcomes between areas close to the stations or line and those farther from its influence would have remained constant over time. Hence, by comparing how these differences change before and after the metro's influence, we can attribute any shifts in trends to the metro's impact. This approach is particularly important in the context of broader changes in the city, such as criminal violence and electricity shortages, as it ensures these external factors—affecting both treated and control areas similarly—are not mistaken for the effects of the PLMQ. The DID framework helps isolate the causal impact of the metro from unrelated contextual changes, providing robust and reliable results.

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6 Gu, Y., Jiang, C., Zhang, J., & Zou, B. (2021). Subways and road congestion. *American Economic Journal: Applied Economics*, *13*(2), 83-115.

7 Anderson, M. L. (2014). Subways, strikes, and slowdowns: The impacts of public transit on traffic congestion. *American Economic Review*, *104*(9), 2763-2796.

8 Gupta, A., Van Nieuwerburgh, S., & Kontokosta, C. (2022). Take the Q train: Value capture of public infrastructure projects. *Journal of Urban Economics*, *129*, 103422.

9 Gendron-Carrier, N., Gonzalez-Navarro, M., Polloni, S., & Turner, M. A. (2022). Subways and urban air pollution. American economic journal: Applied economics, 14(1), 164-196.

10 Alba-Vivar, F. (2024). Opportunity Bound: Transport and Access to College in a Megacity."

11 Scholl, Lynn, et al. *A rapid road to employment? The impacts of a bus rapid transit system in Lima*. No. IDB-WP-980. IDB Working Paper Series, 2018.

12 Zarate, R.D (2024). Spatial Misallocation, Informality and Transit Improvements: Evidence from Mexico City

3.6. For many outcomes, such as those related to urban development, economic activity, education, and employment, the areas of influence are defined by buffers within walkable distances from the stations. In these cases, we exploit realized and unrealized plans for the metro line. Twenty stations were planned at the design stage; however, due to budget and planning constraints, five were not built. These unconstructed sites remain as potential future stations and are likely to serve as suitable locations for the parallel trends assumption to hold. Variability between planned and realized stations offers an identification strategy used previously in the literature in instrumental variable designs[13] and DID models[14] to estimate the impact of infrastructure projects.

3.7. While the parallel trends assumption is untestable, examining trends in periods before the event can provide suggestive evidence on whether the assumption is likely to hold. Additionally, we will check the robustness of the empirical strategy by expanding the selection of comparison areas. For instance, there are five planned stations for an upcoming extension of the first line that has been announced but not yet constructed, and six planned stations that come from historical metro plans from the 1980s that were also never realized. To further increase the robustness of the analysis, additional locations will be included as comparisons in a synthetic DID design[15]. This method reweights comparison observations to match pre-exposure trends, reducing the reliance on the parallel trend assumption.

3.8. Some outcomes can be studied using alternative strategies. For example, a regression discontinuity design with a measure of time as the running variable has been used to study the effect of subways on urban air pollution[16]. A similar approach can be applied to estimate the effect on GHG emissions as the PLMQ began operating. Likewise, if deemed appropriate, straight-line distance[17] and least-cost path instruments[18] can be used to assess accessibility impacts, measuring how proximity to metro stations influences various outcomes.

IV. Description of activities/components and budget

4.1. **Component I: Collection and preparation of data (US$200,000.00)**. This component collects all the activities related to the collection and preparation of data needed to use it to perform an evaluation analysis. Table 1 shows the data catalog that our team has begun collecting already, as well as data yet to be obtained.

Table 1: Catalog of existing data

Source	Data	Availability
Ecuadorian Internal Rent Services Companies Cadastral	Companies' characteristics	Public
Company Directory	Companies addresses	Public
Financial Statements Superintendency of Companies	Sales, taxes, EBIT, assets	Public

[13] Duranton, G., Morrow, P. M., & Turner, M. A. (2014). Roads and Trade: Evidence from the US. Review of Economic Studies, 81(2), 681-724.

[14] Gu, Y., Jiang, C., Zhang, J., & Zou, B. (2021). Subways and road congestion. American Economic Journal: Applied Economics, 13(2), 83-115.

[15] Arkhangelsky, D., et al. (2021). Synthetic difference-in-differences. American Economic Review, 111(12), 4088-4118.

[16] Chen, Y., & Whalley, A. (2012). Green infrastructure: The effects of urban rail transit on air quality. American Economic Journal: Economic Policy, 4(1), 58-97.

[17] Banerjee, A., Duflo, E., & Qian, N. (2020). On the road: Access to transportation infrastructure and economic growth in China. Journal of Development Economics, 145, 102442.

[18] Faber, B. (2014). Trade integration, market size, and industrialization: evidence from China's National Trunk Highway System. Review of Economic Studies, 81(3), 1046-1070.

Transactional Annex	Invoicing	Restricted public
Municipal Properties Cadaster	Land use, property appraisal, property characteristics	Restricted public
Real Estate Portals	Announcement of sale, purchase, and rental prices of properties	Public
Quito's Metro Satisfaction Surveys	User satisfaction by user profile.	Public
Waze	Congestion, commuting times (processed)	Restricted
2022 National Ecuadorian Census	Demographic and labor characteristics at block level	Public
2010 National Ecuadorian Census	Demographic and labor characteristics at block level	Public
National Labor Household Survey (ENEMDU)	Demographic and labor characteristics at parish level	Public
Global Building Volume	Cubic construction meters per cell	Public
Administrative Records of Quito's Metro	Number of users, entry station	Restricted public
Origin and Destination Survey of Quito's Metro 2022	Routes and transport modes, household characteristics	Restricted public
Satellite Nighttime and Daytime Images	Luminosity, Pollution	Public

4.2. First, this component will finance activities required to clean the data that the team has begun collecting, and access additional registry data that is not yet publicly available (see Table 1). The inquiry about data access has already been advanced and access is feasible, although it may require signing agreements with some of the government agencies.

4.3. Second, this component will finance collecting primary data on mobility collected with a survey or alternative datasets that follow up the baseline origin-destination survey designed by the World Bank as part of Quito’s Master Plan. Similarly, any survey will collect trip information, and a rich set of demographic variables segregated by gender and different profiles of disability. Other less expensive alternatives are being explored. For instance, discussions with Telefónica have begun to access travel data captured through enhanced mobile phone data that would also allow to identify transportation modes. Although this data includes fewer demographic characteristics when compared to a survey, it is much more cost-efficient (around 50%) and comparable otherwise.

4.4. To ensure the data is of high quality and suitable for robust analysis, this component will also support data validation and quality assurance activities, including consistency checks, integration across multiple sources, and data documentation. These steps will provide transparency and ensure the data is well-documented and harmonized, ready for use in the evaluation.

4.5. The main objective of this component is to ensure that the data collected and prepared is comprehensive, high-quality, and ready for rigorous impact evaluation. By supporting the cleaning, integration, and validation of data from multiple sources, this component aims to create a robust foundation for analyzing the effects of the PLMQ. The activities funded under this component will result in processed datasets that are harmonized, well-documented, and tailored to address the specific research questions of the evaluation. These datasets will encompass a wide range of mobility, socioeconomic, and environmental variables, enabling robust econometric and statistical analysis.

4.6. **Component II: Analysis (US$155,000.00).** This component will finance activities and human resources needed to analyze data and estimate impacts. Specifically, it will fund the hiring of two full-time data analysts for two years: a data scientist and an economist.

4.7. Under the guidance and supervision of the TC team members, the analysts will perform econometric analyses to address questions such as: what is the effect of the PLMQ on economic activity? Has the PLMQ promoted a shift from private motorized vehicles to public transport? Has the introduction of the PLMQ reduced air pollution? Has the PLMQ alleviated congestion? Has it increased labor market efficiency? What is the impact of the PLMQ on commercial, housing, and rental prices? Does PMLQ improve women's mobility patterns and employment outcomes?

4.8. Activities under this component include exploratory data analysis to identify initial patterns, trends, and outliers; spatial analysis to understand the geographical distribution of outcomes and their relation to PLMQ areas of influence; counterfactual analysis to model what outcomes would have looked like in the absence of the PLMQ; robustness checks to validate the empirical strategies; and subgroup analysis to examine differing impacts across demographics, such as gender, disabilities profiles, and socioeconomic status. Additionally, this component will cover drafting reports, preparing technical notes, and organizing results for dissemination.

4.9. The objective of this component is to produce rigorous research products, capable of informing policy makers both in Quito and the region. This component will generate working papers and technical notes with a gender and diversity focus whenever relevant. The products generated by this component will also document lessons learned from the PLMQ to inform the design and implementation of similar projects across the region.

4.10. **Component III: Knowledge Dissemination (US$20,000.00).** The objective of this component is to facilitate promotion and knowledge sharing. It will fund conference travel, editing services, and a workshop to bring together relevant stakeholders and support the dissemination of findings from the impact evaluation.

4.11. The products generated by this Technical Cooperation (TC) will be incorporated into the IDB's Research & Policy Discussion Paper Series. Specifically, this component will provide support for the editing, systematization, and dissemination of outputs produced under Components 1, 2, and 3.

4.12. All knowledge products prepared and generated by this TC will be the exclusive property of the Bank, granting it sole rights, including copyright. The Bank reserves the right to copy, reproduce, distribute, publish, and display these products in any format or media—whether currently existing or developed in the future—including publications, websites, blogs, catalogs, events, and archives. Publication costs are covered under this component.

4.13. **Indicative Budget.** The indicative budget for the Technical Cooperation (TC) will be US$375,000.00. This amount will be 100% funded by the Ordinary Capital Strategic Development Program W2B - OC SDP Window 2 - Infrastructure. There will be no local counterpart, and the distribution is as follows:

Indicative Budget[19]

Activity/Component	Description	IDB Funding W2B - OC SDP	Total Funding
CI. Collection and preparation of data	Collection and preparation of data needed to use it to perform an evaluation analysis	US$200,000.00	US$200,000.0
C2. Analysis	Data analysis and estimation of impacts	US$155,000.00	US$155,000.0
C3. Dissemination	Conference travel and editing services to support the dissemination	US$20,000.00	US$20,000.00
		Total	375,000.00

V. Executing agency and execution structure

5.1. The execution will be carried out by the Inter-American Development Bank through the Transport Division (TSP/CEC), under the supervision of the knowledge lead specialist, and the local transport specialist. The Bank will be responsible not only for the contracting but also for monitoring, follow-up, and approval of the respective deliverables.

5.2. This scheme is justified by the level of inter-institutional coordination and technical knowledge required for the TC. It has been observed that this scheme is beneficial for the execution of TCs with local governments in Ecuador, as their institutional capacity is currently limited. Successful examples of TCs executed by the Bank include EC-T1286 and EC-T1426. In the case of the Metro de Quito TC (EC-T1378), there was a request to transfer execution to the Bank due to issues specific to the municipal government. Additionally, this TC will utilize the procurement policies of the IDB, which may not be familiar to local governments.

5.3. The determination of which consultancies are selected will respond to a process of dialogue and strategic planning with the client. These consultancies will be conducted according to the Bank's procurement policies for hiring individual consultants or firms as appropriate. All procurement to be executed under this Technical Cooperation have been included in the Procurement Plan (Annex IV) and will be hired in compliance with the applicable Bank policies and regulations as follows: (a) Hiring of individual consultants, as established in the regulation on Complementary Workforce (AM-650) and (b) Contracting of services provided by consulting firms in accordance with the Corporate procurement Policy (GN-2303-33) and its Guidelines.

VI. Major issues

6.1. No major impacts are identified in the execution of this TC, as it involves consultancies, studies, and administrative expenses. However, there is a risk of delays in accessing certain administrative data sources required for the analysis. While some datasets, such as the labor survey ENEMDU, are publicly available, their georeferenced components are restricted and not shared with the general public. In these cases, the team will need to coordinate with governmental institutions, such as the National Institute of Statistics and Census (INEC), to secure access to this otherwise confidential data. To mitigate this risk, the Bank will ensure effective coordination and communication with the relevant institutions to facilitate data access in a timely manner.

VII. Exceptions to Bank policy

7.1. There are no exceptions foreseen to the Bank's policies for this TC.

VIII. Environmental and Social Aspects

8.1. This Technical Cooperation is not intended to finance pre-feasibility or feasibility studies of specific investment projects or environmental and social studies associated with them; therefore, this TC

[19] If additional funding is needed during execution, the team will seek it from other technical cooperations within the Bank or external funding. Preliminary interests have arisen from other multilateral banks that financed the project.

does not have applicable requirements of the Bank's Environmental and Social Policy Framework (ESPF).

Required Annexes

Matriz de Resultados_15372.pdf

Términos de Referencia_1460.pdf

Plan de Adquisiciones_69978.pdf