Impact Assessment Results

Quito, Ecuador

SOLUTIONSplus

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Executive Summary

The Metropolitan District of Quito (DMQ), Ecuador's capital and largest city, faces significant transport issues, especially in its 376-hectare Historic Center (HCQ). The HCQ, a key mobility hub, struggles with narrow streets, high population density, and restrictions on motorized freight, complicating goods distribution and increasing costs for shop owners. Personal mobility issues include traffic congestion, inefficient public transport, and a preference for private vehicles.

To address these challenges, the SOLUTIONSplus project in Quito implemented two strategies: piloting e-cargo bikes and a mobility-as-a-service (MaaS) app. The e-cargo bike pilot, running from November 2022 to January 2023, used seven bikes for delivery, restaurant logistics, and recycling. The long-john e-cargo bike demonstrated high cost-effectiveness for delivery logistics with a payback period of less than one year. CO2 emissions were reduced by up to 247.4 kg annually per bike for deliveries, though no savings were noted for recycling. Overall, the e-cargo bikes were well-received.

The MaaS app, tested by 45 students between November and December 2022, aimed to improve public transport by providing trip planning, timetables, and ticketing. Despite some usability issues, the app has potential to enhance public transport accessibility and reduce private car use if these issues are addressed.

BACKGROUND AND CONTEXT

The Metropolitan District of Quito (DMQ) is Ecuador's capital and largest city, housing about 2.7 million people (INEC, 2020). Located in the northern highlands within the Guayllabamba river basin, Quito's urban growth occurred in three phases: radial until the 1950s, longitudinal from the 1950s to 1990s, and eastern sprawl since the 1990s. The city sits at an elevation of 2,850 meters, making it the world's second-highest official capital and closest to the equator. The Historic Centre of Quito (HCQ), a UNESCO World Cultural Heritage Site, spans 376 hectares and houses around 40,000 residents.

Quito was the second Latin American city to implement a Bus Rapid Transit (BRT) system, which has expanded to five lines covering 136 km and serving 1 million daily trips. Despite this, the system is at capacity, with 40% of its fleet nearing the end of its life. Quito has committed to replacing its BRT fleet with electric buses by 2025 to achieve zero emissions by 2030.

GEOGRAPHY AND THE SOCIAL/URBAN CONTEXT

Quito's topography is diverse, ranging from 500 to 4,870 meters above sea level, contributing to varied climates across the district. The city's elongated plateau is surrounded by volcanoes and mountainous areas, with urban development spreading into the valleys. Average annual temperatures are around 15°C, with varying precipitation levels across the district.

Urbanization in Quito has been uneven, with low urban land use compared to the total area. The population has grown at different rates, with higher growth in peripheral areas and declines in central areas. By 2010, the population had a demographic bonus, with a larger percentage of working-age individuals.

Social and Economic Development

Quito's social and economic conditions are better than the national average. The city contributes 24.5% to Ecuador's GDP, with key sectors being professional activities, manufacturing, and public administration. Transport is a significant contributor to CO2 emissions, accounting for 40% of the city's total.

URBAN TRANSPORT

Quito's public transport system consists of the Metrobus-Q subsystem and conventional private operators. The system is at capacity, leading to a shift towards private cars. A new subway line, operational since 2023, runs north to south, paralleling the BRT routes. Quito is committed to renewing its bus fleet with electric buses by 2025 to achieve zero emissions by 2030.

Identification of Main Problems

Passenger Transport Services

The main issues identified by the Mobility Secretariat (2020) for DMQ's public transport are:

- **Route Redundancy:** Overlapping routes cause service inefficiencies, leading to competition among providers, decreased road safety, low productivity, and increased pollution, particularly in congested areas.
- **Congestion and Road Insecurity:** Saturated roads result in significant congestion and insecurity in the main network.

- **Lack of Complementary Transport Services:** The absence of a coordinated system results in fragmented, individual route networks rather than a cohesive transport system.
- **Basic Business Organization:** Although legally structured as cooperatives or companies, services are operated individually, with operators directly collecting fares.
- **Failure to Meet Schedules:** About 50% of conventional routes don't follow set schedules due to long, exhausting driver shifts, resulting in unmet operational standards.
- **Low Comfort Levels:** Overcrowding exceeds international standards, deterring public transport use and pushing people toward private vehicles.
- **Increased Informal Transport:** Due to insufficient coverage, informal services have risen, often charging higher fees, especially in peripheral areas. The current regulatory framework fails to meet demand efficiently.

Overall, Quito's current transport system struggles to compete with private vehicles, highlighting the need for an integrated approach to urban mobility.

Traffic and Air Pollution in the HCQ Area

The Historic Centre of Quito (HCQ) faces severe traffic congestion, with speeds dropping to 3 km/h during peak hours. Public transport (72%) and walking (19%) are the main modes of travel, but poor pedestrian access and safety concerns exist due to the challenging topography and crowded roads. Additionally, air quality in 2020 was generally acceptable, but vehicle traffic remains a significant pollution source, with pandemic-related restrictions temporarily improving air quality.

Freight Transport Services

Pedestrianization of streets in the HCQ has complicated goods distribution. The narrow streets and population density hinder efficient logistics, with current regulations failing to align with business needs. Many businesses face congestion-related challenges, and restrictions on freight vehicles during the day increase operational costs.

Relevant Stakeholders and User Needs

Relevant Stakeholders

Stakeholders involved in Quito's transport system include various municipal departments (Mobility, Environment, Urban Planning), public transport companies, NGOs, academia, and service providers. Each plays a role in policy, regulation, and implementation of transport solutions.

User Needs

A user needs assessment highlighted the importance of e-vehicles in reducing emissions and improving mobility in Quito. The main challenges identified include lack of financial resources, enabling policies, and safety regulations for e-vehicles. Stakeholders see potential benefits in formalizing transport services, creating new jobs, and improving logistics but recognize the need for careful planning, especially in the Historic Centre. Concerns include the cultural adoption of e-mobility and the need for adequate infrastructure and information to support the transition.

Key Performance Indicators (KPIs)

Prioritization of KPIs Addressing City Needs

Stakeholders in Quito prioritized KPIs through weighted assessments aligned with earlier stakeholder interviews. The aggregation process involved nine stakeholders representing seven groups.

Figures 3 and 4 show the mean weights given to various KPIs at Levels 1, 2, and 3. The weights reflect stakeholder priorities, with cumulative weights ensuring a total of 100 at each level to minimize errors. Level 1 KPIs share identical cumulative and relative weights but differ in scale.

The environment and project finances were the top priorities, each with nearly equal weights (18.65 and 18.35, respectively). Other important areas were society (17.32), climate (16.65), and institutional framework (15.21), while the wider economy received the lowest priority (13.84).

At Level 2, GHG emissions had the highest priority (16.65), followed by financial viability (9.22), air pollutants (6.88), and road safety (2.38). For Level 3, ease of raising external funding (9.12) and recycled resources (5.94) were top concerns, while perceived personal security scored the lowest (0.25).

Baseline Values

Baseline Projections Based on Reference Sources

This section presents baseline socio-economic and environmental indicators for the SOLUTIONSplus project targeting 2025–2030, with data also from 2019.

Socio-Economics and Demographics:

- Ecuador's population is expected to grow by 7.87% by 2025 and 14.07% by 2030.
- GDP projections indicate possible declines, with a 2.7% decrease in GDP per capita by 2025.
- Unemployment is expected to increase slightly from 3.8% in 2019 to 4.1% in 2025.

Environmental Projections:

- GHG emissions from transport are expected to rise, with emissions reaching 2.3 million tCO2eq/year by 2030.
- Daily trips by private vehicles are projected to increase from 25.2% in 2019 to 35.3% in 2030, while public transport usage is expected to decline.

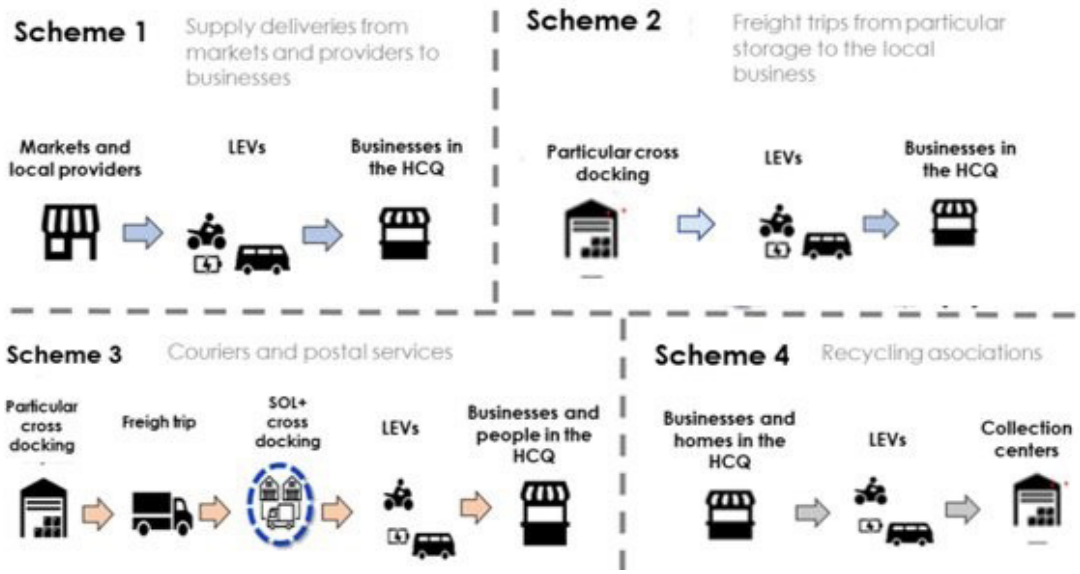
These projections are based on estimates, with unknown impacts from the COVID-19 pandemic potentially affecting future data.

Component 1 – E-Cargo Bike Implementation

4.1. Component Description

The e-cargo bike demonstration supported Quito's plan to create a zero-emission zone in the Historic Centre (HCQ) and was implemented from November 7, 2022, to January 6, 2023. Ten e-cargo bikes, including three models (Long John, rear-loading e-tricycle, front-loading e-tricycle), were introduced.

Local companies ECargoBikeUIO and Sidertech received funding from SOLUTIONSplus to produce ten e-cargo bikes and four e-quadricycles. Additionally, Grupo Miral was selected to design and assemble four e-mini vans for passenger and freight transport. The e-cargo bikes were integrated into local last-mile delivery services.



Altogether, seven logistics operators took part in the pilot, divided onto the different operating schemes as follows:

Supply deliveries from markets and providers to businesses: 2 pilot participants, 5 drivers
Freight deliveries from storage to local businesses: 1 pilot participant, 1 driver
Couriers and postal services: 2 pilot participants, 2 drivers
Recycling deliveries from homes and businesses to the collection centres: 2 participants, 2 drivers

Overall, 16 tons of cargo were delivered during the pilot .The deliveries conducted during the pilot were monitored using GPS tracking as well as user diaries.

Impact Assessment

Financial Viability

Logistics Services: The financial viability was assessed using KPIs like Net Present Value (NPV), Internal Rate of Return (IRR), and payback period.

Long John E-Cargo Bike:

- **Capital Costs:** Purchase price: $2,800, battery cost: $500, useful life: 5 years.
- **Operational Costs:** Yearly costs totaled $2,932, including salaries, electricity, and maintenance.
- **Revenues:** Annual revenue: $6,653. Pre-tax NPV: $11,363; IRR: 130.44%; Payback period: 0.75 years. After-tax NPV: $8,021; IRR: 97.97%; Payback period: 0.97 years.

Restaurant Logistics:

- **Capital Costs:** $3,200.
- **Operational Costs:** Annual cost: $501. Cost-effectiveness: $1.47/$m^3$.

Recycling:

- **Capital Costs:** $3,200.
- **Operational Costs:** Annual cost: $5,935. Cost-effectiveness: $7.74/$m^3$.

Funding Instruments: Potential funding sources include international instruments and city funds supporting the zero-emissions plan for Quito's Historic Centre.

Institutional and Political Indicators

Coherence with National Plans and Development Goals

Alignment with Transport Policies: The project aligns with key national policies, including the Organic Law of Land Transport, National Electric Mobility Strategy, and National Urban Mobility Policy, promoting clean and efficient mobility. At the city level, it aligns with the Sustainable Mobility Plan for Quito and the Historic Center Partial Development Plan, both emphasizing e-mobility.

Alignment with Energy Policies: The project supports the Law on Energy Efficiency, prioritizing electric transport and emission limits for new vehicles, and aligns with Ecuador's Climate Change National Strategy. At the city level, it matches Quito's Climate Action Plan and Low Emission Zone HCQ.

Alignment with Environmental Policies: The project complies with the national regulation on pollution control emissions.

Overall Alignment: The project aligns with national transport, energy, environmental, and overarching policies, earning a STAR value of 5.

Alignment with Supra-National/National/City Legislation & Regulations

Regulations relevant to the project are summarized in Table 11. One area of uncertainty is the management of used acid batteries under the Extended Producer Responsibility regulation, giving this indicator a STAR value of 4.

Ease of Implementation in Terms of Administrative Barriers

Administrative Interventions Needed: The project requires approval from political bodies for ordinances, municipal space usage, and micromobility regulation. Barriers related to homologation and imports for local manufacturing must be addressed.

Institutional Support: While political bodies are in place, administrative interventions are required, and support from institutional bodies is uncertain, resulting in a STAR value of 2.

Climate-Related Indicators

Impact on GHG Emissions

Logistics Services: The project could reduce CO2 emissions by 274.4 kg per vehicle annually by switching from gasoline-powered motorcycles to e-bikes.

Restaurant Logistics: Switching from gasoline-powered passenger cars to e-bikes for restaurant logistics could save 173.25 kg of CO2 per vehicle annually.

Recycling: Transitioning from manual pushcarts to electric vehicles for recycling has no impact on CO2 emissions.

Environmental Indicators

Impact on Air Pollutants

Logistics Services: Emissions from internal combustion engine (ICE) motorbikes include NOx and particulate matter (PM). Using comparative data, it's estimated that replacing these motorbikes with e-bikes reduces emissions by 0.224 kg of NOx and 0.0053 kg of PM2.5 annually.

Restaurant Logistics: Similarly, switching from diesel cars to e-bikes reduces NOx emissions by 0.464 kg and PM2.5 by 0.023 kg per year.

Recycling: The project had no impact on air pollutants as the previous method used manual pushcarts.

Impact on Noise

Based on rider feedback, the use of e-vehicles reduced noise levels in the Historic Center of Quito (HCQ), with an average satisfaction rating of 4.57 out of 5.

Effect on Recycled Resources

The end-of-life disposal of lithium-ion batteries from e-vehicles poses environmental risks due to toxic materials like cobalt, nickel, and lithium. Without proper recycling regulations in Quito, these materials could harm ecosystems and human health. Each e-bike's battery generates approximately 0.8 kg of waste annually, including harmful substances.

Social Indicators

Impact on Accessibility

Participants rated the e-cargo bikes as moderately improving accessibility to pick-up and delivery locations, with an average score of 3.95 out of 5.

Impact on Delivery Time

Logistics Services: The implementation of e-cargo bikes reduced delivery efficiency by 80%, indicating a need for operational adjustments.

Restaurant Logistics: No significant change in delivery times was observed.

Recycling: The use of e-vehicles reduced the time required for recycling by 70%.

Impact on Road Safety

Vulnerable Road Users: E-cargo bikes were perceived to improve the safety of vulnerable road users, with an average rating of 4.08 out of 5.

Road Accidents: The new vehicles were rated slightly safer than previous ones, with an average score of 3.29 out of 5.

Quality

User surveys rated the quality of e-vehicles favorably in terms of comfort, ease of use, and suitability for adverse weather, with ratings mostly above 4 out of 5. However, perceptions of safety and security were more neutral.

COMPONENT 2 - MaaS Application for Public Transport

5.1. Component Description

A MaaS (Mobility as a Service) application was developed by PlusService to support Quito's public transport needs. The app enabled users to plan multimodal trips, view schedules, purchase tickets, and manage user accounts. Additionally, a Web Assistant app for registration and wallet recharging, and a My Check app for validating digital tickets were created. The pilot ran for a month (Nov 21 - Dec 16, 2022), with 45 students from the National Polytechnic School participating. User surveys and log data were collected to assess the app's impact.

5.2. Impact Assessment

Usability Issues: Usability problems hindered the app's adoption, limiting its potential impact on Quito's mobility system.

Environmental Impact: The app slightly increased public transport use among participants, but since most already used public transport or walked, it had no significant effect on GHG emissions, air pollution, or noise.

Accessibility: The app had little impact on accessibility, with mixed user feedback on its ability to help reach new destinations or choose better connections. Improvements could enhance its potential.

Travel Time: The app did not significantly reduce travel time, with most users reporting no change.

Road Safety: As the app didn't reduce private vehicle use among students, it likely had no impact on road safety. However, broader adoption might decrease accidents by reducing car usage.

Service Quality: Users did not perceive a significant improvement in mobility services or journey planning with the current app version.

Modal Split and Multimodality: The app slightly increased public transport usage but had no impact on reducing private car use or improving traffic network efficiency.

Demand for MaaS: On average, users purchased seven daily tickets and validated six. Usage peaked after four days but declined thereafter. The app's potential was recognized, but usability issues limited adoption.

Conclusion: The pilot's impact was limited due to the participants' low car usage. However, with usability improvements, the MaaS app shows promise for broader adoption in Quito, potentially reducing car use and improving mobility.

Scale-Up Concept and Assessment

The scaled-up project aims to establish a "Quito Historic Center Zero-Emission Logistics" zone as part of the city's climate action plan. This initiative seeks to replace all internal combustion engine (ICE) vehicles in the Historic Center with electric vehicles (EVs), building on a previous pilot project conducted from November 2022 to January 2023.

Baseline:
Quito's Historic Center is a densely populated commercial area with 40,000 residents and around 2,000 businesses. A 2021 survey showed that these businesses receive an average of 1.7 vehicle deliveries per week. Implementing zero-emission logistics in this area could reduce daily ICE vehicle entries by 397, replacing them with EVs.

Scaled-Up Impacts:

- **GHG Emissions:**
  Replacing ICE vehicles with EVs in the Historic Center could reduce CO2 emissions by approximately 296,335 kg annually. However, this estimate is based on several assumptions and may vary.
- **Safety:**
  Expert assessments suggest mixed impacts on road safety. While smaller vehicles could reduce congestion and accidents, the lack of infrastructure for electric bikes and other light vehicles could increase risks, especially for vulnerable road users like pedestrians and cyclists.
- **Security:**
  The transition to electric logistics could present moderate security risks, particularly concerning vehicle safety and infrastructure.

- **Charging Safety:**
  Risks related to charging include electrical shock, fire hazards, and power grid instability. Experts highlighted the need for improved safety measures, especially regarding waste management for batteries.
- **Employment:**
  The impact on employment is uncertain, with some experts expecting limited job creation due to a potential reliance on foreign companies for EV services. There is a potential need for more skilled workers in EV maintenance and design.

Overall, while the scaled-up project holds promise for reducing emissions and improving logistics in Quito's Historic Center, it also poses challenges in terms of safety, security, and employment that need to be carefully managed.

Discussion

In Quito, key transportation challenges included an unattractive public transport system and restrictions on cargo transport due to narrow streets. The project addressed these issues through two components:

1. **E-Cargo Bikes Pilot (Nov 2022 - Jan 2023):**
   Eight e-cargo bikes were deployed in Quito's Historic Center for various logistics tasks, including food distribution, parcel delivery, and recycling. During the pilot, 16 tons of cargo were transported over 2,547 km. Post-pilot, ten bikes were permanently assigned to participants, and between April 2023 and June 2024, they transported 300 tons, covering 25,000 km and avoiding 6 tons of CO_2 emissions. The financial analysis showed that e-cargo bikes are cost-effective and reduce emissions, though they currently lag behind ICE motorcycles in efficiency for deliveries.
2. **MaaS Application Pilot (Nov - Dec 2022):**
   A prototype Mobility-as-a-Service (MaaS) app was tested by 45 students, offering public transport information and ticket purchasing. Despite usability issues, the survey indicated that with improvements, MaaS could encourage a shift from private cars to public transport, helping to address mobility challenges in Quito.

Overall, the pilots demonstrated potential environmental and social benefits, though adjustments are needed for broader efficiency and adoption.

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