

Urban mobility in Niterói: An efficiency challenge

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Introduction:

Currently, it is increasingly regular to be stuck in traffic congestion in most of the major metropolises around the world, like New York, Tokyo, Nairobi, Delhi, São Paulo, and Rio de Janeiro, where millions of people depend daily on efficient transportation systems to fulfill their personal and professional activities. To study these systems we use a discipline within the field of Urban Infrastructure called “Urban Mobility”, which concerns the ability of people to move effectively and safely within a city's territory. It includes various modes of transportation, like underground metro tracks, roads for motor vehicles, bicycle paths, and pedestrian sidewalks. Efficient urban mobility ensures the fluidity of movement while playing an important role in reducing environmental impacts, promoting social inclusion and economic productivity. In other words, it leads to efficient progress. Without proper urban mobility planning, cities may face increased levels of air pollution, loss of productivity, deterioration of residents' quality of life and social inequalities. For that reason, to develop sustainable, efficient and resilient mobility systems should become a central objective for urban planners and public policymakers worldwide. The following case study will analyze urban mobility issues and initiatives of a municipality in the southeast region of Brazil, Niterói.

The Case of Niterói:

Niterói is a municipality in the state of Rio de Janeiro, in the southeast region of Brazil. It lies across Guanabara Bay, facing the city of Rio de Janeiro and forming part of the Rio de Janeiro Metropolitan Area. It was the capital of Rio de Janeiro, from 1834 to 1894 and again from 1903 to 1975. The geography of Niterói, characterized by mountainous regions, which are mostly crystalline terrains and extensive coastline, imposes challenges for urban mobility and development. Many neighborhoods are separated by natural barriers, concentrating traffic on a few major roads and creating congestion during peak hours. The city relies heavily on road transportation, as there is no metro system, and the waterway connection to Rio de Janeiro through ferryboats, although efficient, serves a limited part of the population. Road congestion is a persistent issue, especially at critical points like the Rio-Niterói Bridge access and the Alameda São Boaventura, one of the busiest avenues. Niterói climate is characterized as tropical, like Bangkok, Cancún, Caracas, Ho Chi Minh, Kaohsiung and Townsville. It has an estimated population of 481,749 inhabitants (2022) and an area of 133.757 km²(2023), which is located between the Atlantic Ocean and São Gonçalo. The city has the Oceanic Region, highlighted by its natural beauties and beaches like “Fora”, “Imbuí”, “Itaipu” and “Itacoatiara”. The municipality also has two lagoons connected by the Camboatá Canal, Piratininga and Itaipu. The lagoon of Itaipu, by their turn, is connected at the sea through the Itaipú Canal. Its economic activities are historically centered around commerce, the naval industry, and petroleum extraction. Niterói is currently experiencing a growing number of adult inhabitants, and the city is expected to reach its population peak by 2050. Regarding the territory, concerns over flooding and rising sea levels are visible, and projects

are already underway to address these issues, like the construction of a subterranean reservoir in Caio Martins Stadium, which will receive water from the new drainage network. The Green areas are characterized by Atlantic Rainforest, but which decreased significantly since the discovery of Brazil by Portuguese, today being preserved only in a few places, like Tiririca Mountain Range and City of Niterói's Park. As for economic activities, the naval industry has weakened, particularly since the 2014 Brazilian economic crisis, which was triggered by a series of supply-demand shocks, in other words, a sudden change in supply and/or demand of goods and services. Urban infrastructure regarding mobility is guided by the Sustainable Urban Mobility Plan (SUMP), which promotes incentives for public transportation and non-motorized transport modes. The SUMP report also highlights a significant demand for transport connecting Niterói's city center and the Icaraí neighborhood to the surrounding macrozones.

The main problem for Niterói:

The main urban mobility issue in Niterói is traffic congestion, which strongly affects the daily lives of its inhabitants. Traffic bottlenecks are especially common during peak hours that are 6 AM and 5 PM in key areas such as the access to the Rio-Niterói Bridge and Marques do Paraná Avenue. The heavy reliance on private vehicles, combined with a road network constrained by the city's mountainous geography and limited cross-city connections, has intensified this congestion problem over the years. One of the strategic solutions proposed to tackle this challenge is the expansion of efficient public transportation systems, notably through the implementation of a Light Rail Transit (LRT) system. The LRT aims to provide a reliable, fast, and low-emission alternative to road transportation, reducing the number of individual vehicles circulating in the city and promoting a shift towards collective transport modes. However, despite the strong potential benefits, the LRT project is heavily dependent on federal funding. This dependency creates a significant challenge because the Brazilian federal budget has been facing increasing constraints, particularly in the area of discretionary expenditures. Discretionary expenditures, which include investments in infrastructure projects, have been progressively shrinking due to fiscal adjustments and rising mandatory spending, such as pensions and social programs. As a result, to ensure the necessary financial resources for the Light Rail construction becomes uncertain and subject to political and economic negotiations at the national level. Measures to address urban mobility issues in Niterói have already begun, as indicated in the Sustainable Urban Mobility Plan (SUMP). Furthermore, it is essential to notice that a LRT relies on energy supply, a variable which could represent a challenge since power outages have become common within the municipality, which by their turn, looks connected with Energy theft and Infrastructure variables. The SUMP outlines a series of public works projects categorized into short, medium, and long-term initiatives. Among the main interventions are the development of a Bus with High Level of Service (BHLS) corridor, which aims to enhance the efficiency and attractiveness of bus transport; the requalification of General Castrioto Street, to improve traffic flow and pedestrian safety; and the long-term implementation of the Niterói Light Rail Transit system itself. These initiatives are designed to optimize urban mobility, enhance accessibility between different areas of the city, and reduce pollutant emissions by encouraging a modal shift away from private cars towards collective and sustainable transportation alternatives. The effective execution of these plans will require more than only technical planning and public engagement. It will require overcoming financial, political, and administrative hurdles to secure the necessary funding and to manage the complex execution process.

Analysis from Urban Infrastructures Management Perspective

The urban mobility challenges faced by Niterói are multifactorial, requiring a detailed examination through the lens of Urban Infrastructure Management. This analysis aims to understand the root causes of traffic congestion in the city, evaluate the current institutional and financial frameworks, and assess the feasibility and impact of proposed solutions, such as the Light Rail Transit (LRT) system. By exploring how Niterói's geography, governance structure, economic capacity, and social dynamics interact with transportation infrastructure, this section seeks to present a holistic view of the problem. Furthermore, the analysis will consider the alignment between local mobility plans and national policies, while highlighting the structural and budgetary limitations that influence project implementation and long-term urban resilience.

To understand Niterói's urban mobility challenges, it is necessary to start with a geographical analysis. Niterói is a municipality characterized by an irregular terrain composed mostly of crystalline massifs and coastal hills. The Tiririca Mountain Range, among others, presents natural barriers that fragment the city and create difficulties in territorial integration. The topography limits the expansion of road infrastructure, concentrates traffic into slight corridors, and contributes to bottlenecks. Historically, the bay has served as both a barrier and a bridge in the economic and social integration between Niterói and the city of Rio de Janeiro.

A major piece of infrastructure built to address this geographical separation was the construction of the President Costa e Silva Bridge, popularly known as the Rio-Niterói Bridge. While the bridge significantly improved connectivity between the two cities, it also created a dependency on road transportation and generated new issues, such as chronic traffic congestion at its access points. Today, the bridge handles over 150,000 vehicles daily, often resulting in delays and stress on the urban road network. An alternative mode of transportation, the ferryboats, offers a faster and more environmentally friendly route across the bay. However, their usage is limited due to the location of the terminals being concentrated in central Niterói. This reduces accessibility for residents of peripheral neighborhoods, thus limiting the effectiveness of this modal. Despite efforts to incentivize usage through integrated ticketing systems that reduce prices, this might generate concerns about overcrowding since the accessibility of the prizes may not grow in the same proportion as the supply of this service.

From a historical standpoint, Niterói was the capital of the state of Rio de Janeiro during multiple periods (1834-1894 and 1903-1975). This legacy has left the city with a relatively well-developed civic and administrative infrastructure but, at the same time, may have concentrated development in central regions, particularly around the neighborhoods of Centro and Icaraí. The resulting urban sprawl, combined with limited east-west and north-south transit corridors, has contributed to uneven development and mobility bottlenecks. The historical prioritization of individual car use over public transportation, as signposted by Juscelino Kubitschek politics and absence of regulations establishing a common pattern with regards the train gauge within national territory, has aggravated these challenges, leading to a weakening in national integration and low accessibility in outlying regions in a macro and micro perspective.

Demographically, Niterói is home to an estimated 481,000 residents (2022), with projections indicating a gradual increase until it reaches its population peak by 2050. The population is aging, and the growth rate is slowing, which adds new dimensions to mobility planning. Older populations may require more accessible public transport options, and the overall demand for public infrastructure may change over time. Nevertheless, the current transportation network still faces pressure from daily commuting patterns, especially those involving trips to and from Rio de Janeiro. The growing number of daily commuters, combined with the lack of a metro system and limited public transport coverage in certain areas, amplifies the need for integrated, multimodal, and sustainable mobility solutions.

Regarding infrastructure, road transportation remains dominant, with the access roads to the Rio-Niterói Bridge being key congestion points. There is no metro system in Niterói, and the bus system suffers from inefficiencies such as lack of prioritization on the roads and inconsistent service in peripheral neighborhoods. Geographic barriers further complicate the situation. To address the isolation caused by hills and mountainous terrain, the city has invested in tunnel construction. One notable example is the Charitas-Cafubá Tunnel, which cost approximately R\$310 million (US\$83.78 million at the time) and was designed to link eastern neighborhoods with better-developed central zones, improving connectivity and easing traffic on coastal roads.

In terms of proposed solutions, the main long-term strategy outlined in the Sustainable Urban Mobility Plan (SUMP) is the implementation of the Light Rail Transit (LRT) system. The proposed line would connect the Charitas Terminal to the Barreto neighborhood, passing through central Niterói. This project is intended to serve as a pillar for public transport, integrating with bus lines and non-motorized transport modes. The LRT promises to reduce greenhouse gas emissions, improve travel times, and offer a more equitable and accessible transportation option for all residents. However, the success of this project is heavily dependent on federal funding, which is currently constrained due to shrinking discretionary space in the national budget caused by an increase of the State's debt and retirement of civil servants, who starts to retire more quickly since the Brazilian population is aging faster and this can be proven by the fact that the number of children/woman in 2000 was 2,32 and 1,58 in 2022 (a fall of 0,74 points) while Argentina in 2000 was 2,59 in 2000 and 1,88 in 2022 (a fall of 0,71 points). At the same time, the increase of tax may not be enough in the foreseeable future since Brazil is almost reaching his "Laffer's Curve" vertex and this can be proven by the research "Empirical verification of the Laffer's Curve for Brazil between the years from 1996 to 2014".

Other short- and medium-term measures include the implementation of a Bus with High Level of Service (BHLS) corridor, requalification of General Castrioto Street, and improved facilities for cyclists and pedestrians. These measures aim to improve accessibility and encourage the use of alternative modes of transport. Nevertheless, all these projects face bureaucratic, institutional, and financial hurdles. The alignment of local initiatives with federal policies, the availability of technical expertise, and the institutional capacity to execute large-scale projects remain critical variables that most likely determine the overall success of Niterói's mobility transformation.

Conclusion:

In light of the information presented, it is clear that Niterói is currently facing significant challenges in the field of urban mobility. These challenges are not isolated or temporary but derive from a combination of geographic, demographic, economic, and infrastructural elements that require a coordinated and well-funded response. The city's topography, with its massifs, coastal hills, and limited flat areas, already restricts the expansion of road networks and concentrates traffic along specific corridors. Additionally, the historical dependence on road transport, limited integration with the ferry system, and the lack of a metro line aggravated the congestion problems faced by the municipality.

Despite the recognition of these issues and the existence of comprehensive plans—such as the Sustainable Urban Mobility Plan (SUMP)—the implementation of effective solutions remains uncertain due to Brazil's current budgetary limitations. The proposed Light Rail Transit (LRT) system, for instance, presents a promising alternative that could transform mobility patterns in the city by improving accessibility and reducing reliance on individual motor vehicles. However, its execution depends heavily on federal funding, which has become increasingly insufficient due to the shrinking space for discretionary expenditures within the national budget. This fiscal constraint creates a restriction not only for mobility-related investments in Niterói but for urban infrastructure projects across the country.

In this context, it becomes evident that without a general fiscal reform at the federal level—enabling more budget for infrastructure projects—it is unlikely that major public transportation projects will materialize in the short or even medium term. To overcome this barrier, the participation of private companies through public-private partnerships (PPPs), full private urban infrastructure projects and/or the engagement of international financial institutions and development agencies may be essential. Such partnerships could provide the capital and technical expertise required to implement complex infrastructure projects, while also sharing financial risks.

Therefore, while Niterói has identified its key urban mobility problems and laid out viable strategies to address them, the city's ability to move forward will depend on systemic changes beyond its municipal authority. Without reforms in public finance, increased private sector collaboration, and/or access to external funding sources, both Brazil and Niterói are likely to continue facing serious hurdles in their quest for sustainable, inclusive, and resilient urban mobility.

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