

# Managing the Urban Environment of Rio de Janeiro, Brazil

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**How to cite this paper:** Edelman, D. J. (2024). Managing the Urban Environment of Rio de Janeiro, Brazil. *Current Urban Studies*, 12, 123-151.  
<https://doi.org/10.4236/cus.2024.122007>

**Received:** March 2, 2024

**Accepted:** June 8, 2024

**Published:** June 11, 2024

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## Abstract

This article brings the contemporary thinking and practice of Urban Environmental Management (UEM) to the solution of current and persistent environmental problems in Rio de Janeiro, Brazil. Rio de Janeiro, or simply Rio, is the capital of the State of Rio de Janeiro. With more than 84% of Brazil's population living in cities, it is the 2<sup>nd</sup> most populous city in Brazil (after São Paulo) and the 6<sup>th</sup> most populous city in the Americas. Part of Rio de Janeiro is designated as a World Heritage Site. Rio de Janeiro has the second largest municipal GDP in the country and 30<sup>th</sup> largest in the world in 2008. It is also a polluted metropole plagued by serious environmental problems. The article first considers the context of Rio, and then reviews issues of poverty alleviation, industry, energy, transportation, wastewater & solid waste, water and finance. Finally, it proposes a 5-year Plan to help alleviate the city's urban environmental problems by utilizing a real-world database and working within Brazil's financial institutions.

## Keywords

Urban Environmental Management, UEM, City, Regional Planning

## 1. Introduction: Research Framework

Urban Environmental Management or UEM (Bartone, 1991; Lee, 1994; Leitman, n.d.) has been receiving serious attention since 1970 in developing countries, where it has become an area of academic research, professional practice, and donor concern. As a field, it is more like planning and engineering rather than geography, economics, or sociology, although it does draw from those subjects as well. Critically, it represents an integrated view of environmental problems at the city and regional levels. Such problems are multi-sectoral (e.g., manufacturing, services, household, etc.), multi-system (e.g., water supply, sanitation, transport,

etc.), and multi-actor (e.g., government, NGO, CBO and private). They require solutions of enormous complexity, and those professionals who coordinate the planning, implementation, and management of the process must be able to communicate with experts from many disciplines and professions (e.g., biology, chemistry, engineering, city and regional planning, public administration, social sciences and law) (Edelman, Schuster, & Said, 2017). This article focuses on the practice of Urban Environmental Management in developing countries which face more immediate, critical problems than the developed world and have fewer resources to deal with them in a comprehensive manner. Case studies, such as the one discussed in this article, contribute directly to understanding and coping with these problems.

This study, then, is the report of a graduate-level workshop that took place in the School of Planning (SOP), College of Design, Architecture, Art and Planning (DAAP), University of Cincinnati, USA from August through December 2023. The objective of the workshop was to prepare students to work overseas in data-poor environments as professional consulting planners. Several lectures were given to set the study framework for the mixed class of 17 domestic and international students. An introduction to Brazil in general and Rio de Janeiro was presented to the students after a thorough investigation by the instructor. They would operate in 7 collaborative sector-level teams (i.e., poverty alleviation, industry, energy, transportation, wastewater & solid waste, water, and finance) preparing a 5-year Environmental Plan for Rio de Janeiro, Brazil utilizing a real-world database and a limited, but realistic budget (Edelman, 2024). The final plan was the result of an extensive and intensive literature review that lasted five months.

Rio de Janeiro, or simply Rio, is the capital of the State of Rio de Janeiro. With more than 84% of Brazil's population living in cities, it is the 2<sup>nd</sup> most populous city in Brazil (after São Paulo) and the 6<sup>th</sup> most populous city in the Americas. Part of Rio de Janeiro is designated as a World Heritage Site (UNESCO, 2012). Rio de Janeiro has the second largest municipal GDP in the country (IBGE, 2008) and 30<sup>th</sup> largest in the world in 2008 (City Mayors Statistics, 2007). This is estimated at R\$ 343 billion, or just under US\$ 68 billion (one Brazilian Real = US\$.20). In the city is the headquarters of Brazilian oil, mining, and telecommunications companies, including 2 of the country's major corporations, Petrobras and Vale, and Latin America's largest telemedia conglomerate, Grupo Globo. The home of many universities and institutes, it is the 2<sup>nd</sup> largest center of research and development in Brazil, accounting for 17% of national scientific output according to 2005 data (Universidade Estadual de Campinas (Unicamp), 2005). Despite the high perception of crime, the city actually has a lower incidence of crime than most state capitals in Brazil.

Rio de Janeiro is one of the most visited cities in South America and is known for its gorgeous natural settings, many lovely beaches, such as Leblon, Barra da Tijuca, Copacabana, and Ipanema, its large and raucous Carnival, and the music

and dance of bossa nova and samba (BBC World News, 2009). In addition to its famous beaches, some of the most famous landmarks include the giant statue of *Christ the Redeemer* on Corcovado Mountain and Maracanã Stadium, one of the world's largest football stadiums.

## 2. Poverty Alleviation

Urban Brazil is characterized by a striking contrast between rich and poor. Inequality is a characteristic of every large Brazilian city including Rio. Urban Brazil is dominated by social exclusion, often structured around exclusionary land markets and individualistic property rights (Fernandes & Valença, 2001). Moreover, urban growth in the country over the last 50 years has been rapid and has exacerbated spatial segregation and social exclusion (Ibid.). Rio de Janeiro is no exception. It is a city of 6.3 million and a region of 11.7 million people on the southeast coast of Brazil (Favela-Bairro, n.d.). The city's population has grown substantially in recent years due to urbanization and natural increase, with approximately 65% of urban growth resulting from migration driven by various push and pull factors.

However, this rapid population growth has created a severe housing shortage, leading millions of people to build their homes using scrap materials like wood, corrugated iron, and metal. These makeshift settlements known as *favelas* are slums that are typically located on the outskirts of most major Brazilian cities. Unfortunately, conditions in favelas are rather poor, with families often sharing a single water tap, with no sewerage provision, and high unemployment rates.

Favelas are usually situated on the fringe of cities for two main reasons. First, it is often the only available land within the city limits. Second, industries tend to be located on the outskirts of cities, and people need jobs, so they settle close to factories. These settlements may sometimes be found as far as 40 or 50 km from the city center, along main roads and on steep hillsides. The poor infrastructure in the typical favela often leads to issues with electricity and plumbing, making daily life challenging for residents.

Unfortunately, sanitation standards are non-existent in favelas, leading to rampant disease. Health risks in favelas arise from overcrowding, pollution, and inadequate waste disposal systems, leading to a life expectancy of approximately 48 years compared to the national average of 68. Living conditions in favelas often lead to high crime rates. Drug trafficking is rampant, with a majority of the gang members being young male teenagers.

Most recent surveys show that there are around 1.5 million people living in Rio's favelas, which accounts for approximately 23% to 24% of the population of the City of Rio de Janeiro's 6.3 million (Catalytic Communities, 2022). However, the informal nature of the favelas is not their only defining characteristic. Favelas have developed their own sense of culture and pride, in the same way that residents living in formal settlements can feel about their neighborhoods, and it has created a great sense of community in the favelas.

## 2.1. Bolsa Familia Program

The Bolsa Familia Program, known in Brazil as the *Programa Bolsa Família* (PBF), was introduced in 2003 under President Lula da Silva after high levels of hunger, poverty, and inequality plagued many urban areas of Brazil. This conditional cash transfer program supports low-income families who, in exchange for the cash transfer, ensure that they are sending children to school and providing proper medical care. The main objectives of the program include reducing poverty and inequality by providing a minimum level of income for extremely poor families, breaking the cycle of poverty by making income transfers conditional as it aims to break the poverty cycle by investing in human capital, along with empowering PBF beneficiaries by linking them to complementary services like employment training and social assistance programs (Bolsa Família in Brazil, 2019). This program has been incredibly successful across the country and has especially helped to reduce levels of inequality throughout the favelas of Rio de Janeiro.

Eligible households with a per capita monthly income up to R\$ 70 or US\$ 14 at the program's inception in 2003, were "entitled to a fixed household transfer of R\$ 70 plus an additional amount of R\$ 19 for each child up to fifteen years of age, to a maximum of five, and an additional amount of R\$ 38 for each youth aged sixteen to seventeen, to a maximum of two. The maximum benefit amount for households in extreme poverty was, therefore, R\$ 242 (US\$ 48.40)" (Ibid.). This program was revolutionary since traditional social safety nets were proving to be ineffective. Many poor Brazilians earn their living through the informal sector, which is harder to serve through social safety nets, which perpetuates inequality throughout the country.

Since the Bolsa Familia Program's inception in 2003, the PBF has provided conditional cash transfers to over 46 million people, so about every one in four families in Brazil receives benefits from this program (Ibid.). According to the World Bank, by 2015 the percentage of the population of Brazil living below the international poverty line dropped from 13% to 3%, and without the program, it is estimated that "the level of extreme poverty would be between 33% and 50% higher" (Ibid.).

This directly affects Rio de Janeiro's urban poor living in the favelas as many are beneficiaries of the PBF. However, just because residents are receiving these conditional cash transfers, it does not mean that they are not susceptible to the recessions that hit the Brazilian economy. Poor Brazilians are disproportionately affected by shocks to the economy, and this can conflict with the progress made by the Bolsa Familia Program.

## 2.2. Housing

To understand housing, it's essential to understand that the lower classes in Rio de Janeiro live in the favelas. These slums are located on hills that overlook the beautiful city and are surrounded by wealthy neighborhoods. Favelas were constructed on these hills due to the high risk of landslides in the upper-class

neighborhoods. Unfortunately, poverty is a significant issue in favelas, and many of the houses are more like shacks than proper homes. The streets and houses are often filled with waste, leading to the spread of disease. In contrast, upper-class and middle-class residents live in houses built with wood, brick, concrete, marble, or granite below these favelas. These houses are usually constructed in complexes with two stories, two bedrooms, and one and a half bathrooms, and are similar to American townhouses (Wikimedia, 2023).

Nevertheless, according to a survey, 95% of favela homes are built of materials that include some brick, concrete, and reinforced steel, much of them scrounged from building waste in the wealthy areas, and 75% have at least partial tile floors. Residents have spent decades of income and physical labor constructing and consolidating their homes. Some of these older favela houses now have some combination of electricity, running water, indoor plumbing, large-screen televisions, and, in over 44% of cases, a computer. The prevalence of technology in favelas has led to increased internet access for over 90% of residents under 30 as of 2012 (Robertson, 2018). Data from 2018 show that favela residents are more technologically connected than those living in the formal city.

Nevertheless, it is worth noting that 30% of Rio's population lacks proper sanitation, including some of Rio's favelas and wealthier neighborhoods. Yet favela-style development creates some incredible efficiency. Because neighborhoods are low-rise and high-density, favelas have historically been built in areas of employment, and their residents, many of whom are construction workers with building expertise, have worked together to ensure that everything from daycare to housing is guaranteed with limited financial resources. Encouraging exchange and mutual support among residents has been a non-financial investment, which is as critical as financial investment, to safeguard positive outcomes for communities.

In addition to the above characteristics, favelas have won numerous legal victories, recognizing adverse possession and squatters' rights. Although public utility services such as electricity and water are often substandard, they are, nonetheless, available to many individual homes in most favelas today.

### 3. Industry

The accelerated development of Brazil increased after the country's independence in 1822. The official abolition of slavery in 1888 allowed for more market growth of industrial exports, backed by the large influx of European settlers. After a contraction in Brazil's economy due to decreased coffee exports, the Great Depression, and WWII, Brazil was primed to industrialize. Rio de Janeiro and São Paulo, as the two largest cities in the country, became production centers for transportation exports like cars and construction materials such as steel. The industrial sector of Brazil became a large part of the economy in the wake of post-slavery agricultural exports (Amann & Trabat, 2014).

However, the impact of slavery in the form of racism still exists. Within mu-

nicipalities, only 39% of black and 28.7% of brown people lived with specific municipal legislation promoting racial equality and/or combating racism. Of those where the administration developed a policy or program, 62.8% were black people and 53.4% were brown (IBGE op. cit.). Within cities that have high proportions of black and brown people, the rates of these policies being implemented are higher than in cities where they represent a smaller percent of the population. Not enough work is being done within industries in Brazil and Rio de Janeiro to reduce this income inequality and make employment practices equitable.

Moreover, Brazil and Rio's infrastructure is poor, which negatively affects industry. In a comparative study of the infrastructure quality of 144 countries completed by the World Economic Forum, the quality of Brazil's roads was 120<sup>th</sup>, railroads at 103<sup>rd</sup>, ports at 131<sup>st</sup>, air transport at 123<sup>rd</sup>, and electricity supply at 76<sup>th</sup> (World Economic Forum, 2013).

This lack of quality in Brazilian ports is especially worrisome when considering that 95% of the country's trade by volume is completed through ports (Amann & Trabat, 2014). According to Micco and Perez (2002), tariffs in Brazil were 3 to 6 times higher than the international average, with ships also having to wait longer. According to one report: "While Brazilian ports handle on average 34 containers per hour per ship, ports such as Hamburg handle 66 containers and Singapore 100 Containers." Delays in loading/unloading and customs clearance lead to trucks queuing for longer times, delaying imports and exports, leading to less economic competitiveness" (Ibid.).

In general, the underinvestment in infrastructure within Brazil limits Rio de Janeiro's economic potential, stunts job creation, and lessens the wellbeing of its people by not providing adequate services.

### 3.1. Tourism Industry

Nevertheless, Brazil is recognized as an important economic player, which allows for larger opportunities for international tourism and growth in the tourism industry. Rio de Janeiro's unique beaches, iconic landmarks such as Christ the Redeemer, Carnival, and the favelas along the hillside draw many tourists to the city. With tourism providing 2.2 million direct jobs in the country, it is an important pillar of Brazil's economy. Brazil's tourism industry attracted 6.4 million international tourists in 2019, with US\$ 6.1 billion in international receipts spent in 2019 (OECD, 2022). However, COVID-19 massively impacted the country's international market, with a 66% decline in international tourists, and a 49.4% decrease in international receipts in 2020 (Ibid.). This largely has to do with the partial cancellation of the Carnival during the pandemic, which serves as a large economic driver for the tourism industry and country.

### 3.2. Oil and Gas Industry

The oil and gas industry is another major part of Rio de Janeiro's economy, with 15% of the workforce in Rio exclusively employed in the oil market. Brazil itself

is one of the world's 10 largest oil producers, with a production of 3 million barrels per day of oil and 134 million m<sup>3</sup>/day of gas, most of which is mined through ocean water rigs (Ibid.). The industry is also projected to generate 456 thousand jobs annually and provide US\$ 65 billion in revenue for the government between 2023 and 2031 (Ibid.). The discovery of vast offshore oil reserves in the ocean by Rio and the government's push for energy production has led the city to become one of the largest producers in the country.

### 3.3. Manufacturing Industry

The manufacturing sector, encompassing industries such as textiles, food processing, and automotive production, is another important component of Rio de Janeiro's economy. It accounted for 9.8% of Brazil's GDP in 2020 and has employed around 11% of Brazil's workers over the last 20 years (Instituto Brasileiro de Geografia e Estatística—IBGE, 2023). Unfortunately, the COVID-19 pandemic brought many challenges to the manufacturing sector, causing many production line shortages and the paralysis of production lines. Another important element of industry in Rio de Janeiro is that the state of the industrial sector within the city is heavily affected by the local government, and the impact from lack of action from the local government can have dire effects on many aspects of day-to-day life for Brazilians and the places where they work. Transforming industrial-focused policies to better assist and benefit the individual worker can supply long-lasting benefits for the industrial sector's strength and resilience. Particularly in the last few decades, because of the rise of global communication and the looming pressure of the ever-worsening climate crisis, an emphasis for industries to take on a more humane and environmentally conscious stance for their processes has proved to have a considerable economic impact on determining what industries and businesses thrive, and which do not.

### 3.4. Environmental State

Industries and the environment have always been at odds with each other. It is very clear how damaging current industrial practices can be for the environment around them. One need only look at carbon emissions before and after the industrial revolution to see that the two forces are intrinsically at odds with each other. Yet both are vital for the health and prosperity of a country, and the degradation of one aspect can have dire effects on society. Environmental impacts need to be considered in the discussion of industrial functions no matter where the discussion is being held. But this conversation is particularly important in places such as Rio de Janeiro, which has an incredibly delicate ecosystem and has suffered consequences from a lack of care for it in the past.

The environmental damage within Rio de Janeiro is no secret. A major talking point leading up to and during the 2016 Olympics was the city's pollution. Trash lined the waterways where numerous events were held, and bacterial infections caused concern for athletes and tourists visiting the city for the event. The

growing conversation around the polluted state of Rio opened the conversation around the world about urban pollution control, but many of the issues within Rio persisted after the games concluded. While there are many factors that contribute to pollution control within the City of Rio de Janeiro, a major contributor is industrial practices, especially those due to the tourism industry.

Rio is a highly trafficked tourist destination because of its tropical atmosphere, cultural identity, and presence of landmarks such as Christ the Redeemer. This tourism has immense effects on the pollution within the city. Common traits of products made for tourists are that they are single-use and made of cheap, low-quality materials that are easily producible but also easily disposable. While the tourism industry is clearly not the only contributor to urban pollution, which is only exacerbated by infrastructure issues and local legislation, it is a prime example of the effects of the industrial sector on the local environment.

This inner-city pollution caused by the tourism industry has largely been ignored by the local government in Rio de Janeiro in terms of political action towards the pollution problem, causing citizens to largely take up the reins themselves and clean up the city. Areas such as the Guapimirim Environmental Protection Area, administered by the Chico Mendes Institute for Biodiversity Conservation shows how these areas can be effectively protected, and the group helps protect the biodiversity within the surrounding areas and in Guanabara Bay. This group has helped immensely with protecting and restoring ecosystems within the protected area, and it could make an enormous impact on the City of Rio de Janeiro if efforts seen in the protected area were utilized to help mitigate the pollution generated within the city.

### **3.5. Desired Industry Direction**

Industries in Rio de Janeiro and Brazil have had a complicated, rocky history that has largely continued to this day. It is vital for the country to maintain its industrial power to ensure its place in the global economy is secure, and yet that industrial power comes from a long history persisting to the present day that exploits vulnerable individuals and ecosystems. To ensure the health of Brazil and its people, the injustices that are caused by the demands of the industrial sector must be dealt with. For example, thousands of individuals are enslaved through debt bondage and other means within Brazil to supply products such as charcoal and cacao beans. This must be eliminated as part of the much-needed change to industrial health in Brazil.

Brazil has a long history of corruption and exploitation of the people, and yet political pressure could be the one thing that can help improve this crisis. To achieve this, progressive Brazilian groups would need to work to advocate and push the government to enact a new policy, which protects the rights of Brazilian workers by implementing regulations and more in-depth supervision of worker compensation and treatment. It would ensure that workers are paid a living wage and feel safe and comfortable in the places where they work. While

efforts like this can begin to make tremendous impacts within Rio de Janeiro to help improve workplace experiences for the inner city, it is vital that it be extended to the entire country, as every industrial plant and every individual location which contributes to a step in the industrial process affects how industries function within the City of Rio de Janeiro. At the end of the day, if one Brazilian is at risk for exploitation from the industrial sector, every Brazilian is at risk. This sector affects nearly every aspect of the lives of individuals living in Rio de Janeiro and throughout Brazil. It is up to everyone, including policy makers, activists, industrial leaders, civil groups, and many more, to effectively change the functions of industries to a healthier, more efficient, more environmental, and overall, better entity within Brazil.

## 4. Energy

### 4.1. Energy Overview

Rio de Janeiro is a pivotal player in the country's energy sector. Renowned for its iconic landscapes, Rio is equally noteworthy for its significant contributions to the energy sector. The city's energy profile is deeply intertwined with Brazil's quest for sustainable development, as it grapples with the dual challenges of meeting the growing energy demands of its burgeoning population while striving to reduce energy's environmental impact.

This section offers insights into the complexities of Rio's energy sector and offers viable strategies for a more just and efficient energy future. Against the backdrop of a changing global energy landscape, Rio de Janeiro's energy trajectory reflects the broader trends and challenges facing urban centers in the pursuit of a resilient and sustainable energy future.

### 4.2. Rio's Energy Sector

The energy sector has traditionally played a crucial role in Brazil's overall energy landscape, with a focus on hydroelectric power and oil production. The region has been a significant contributor to the country's energy mix, hosting key facilities and infrastructure related to oil exploration and refining. Additionally, efforts towards diversification and sustainability have seen Rio de Janeiro making strides in incorporating renewable energy sources, including wind and solar power, into its grid. The state has been navigating the challenges of meeting rising energy demands while addressing environmental concerns, reflecting broader trends in the global energy transition. Policymakers and industry stakeholders continue to shape Rio's energy sector, aiming for a balance between conventional and cleaner, more sustainable energy resources to secure the region's energy future.

### 4.3. Rio's Energy Mix

To meet its energy needs, Rio de Janeiro employs a diverse range of energy sources:

- **Hydropower:** The leading energy source for Rio de Janeiro is hydropower, which takes advantage of the abundance of water resources in the state. By harnessing the power of rivers and dams, Rio generates clean and renewable energy. Hydropower plays a crucial role in meeting the increasing demand for electricity in the region, with the Itaipu Dam on the Paraná River as one of the largest hydroelectric plants globally, supplying a substantial portion of Rio's electricity needs.
- **Natural gas:** The region's extensive natural gas reserves are widely utilized for power generation and industrial processes in Rio de Janeiro. Natural gas-fired power plants provide an efficient and flexible solution for meeting electricity demand, ensuring a stable and consistent energy supply.
- **Oil:** Rio de Janeiro's offshore oil reserves make it a key player in Brazil's oil industry. The extraction and refining of petroleum products significantly impact the regional economy and energy sector. However, addressing the risks associated with overreliance on oil as a primary energy source, such as energy security and sustainability concerns, is essential. This highlights the need to explore alternative energy sources and diversify the energy mix further.
- **Electricity:** The demand for electricity in Rio de Janeiro has been steadily increasing, necessitating electricity production from various sources. In addition to hydropower and natural gas, electricity is generated through thermal power stations, biomass, and other renewable energy sources. This diverse energy mix enhances resilience and reduces risks associated with dependence on a single energy source.
- **Nuclear:** Rio de Janeiro's regional energy mix includes the Angra Nuclear Power Plant. Nuclear power contributes to a stable, low-carbon energy source, reducing Rio's carbon footprint.
- **Solar:** Due to Rio de Janeiro's sunny climate, solar energy has gained traction as an alternative energy source. The city has implemented various solar energy projects, including rooftop solar panels and solar farms, particularly in the favelas of Rio. These projects promote energy justice and decentralized energy production.
- **Wind:** Rio de Janeiro has also implemented wind energy projects, taking advantage of the region's strong winds. While wind power contributes to Rio's overall renewable energy portfolio, its potential is limited due to geographical constraints.

#### **4.4. Production, Distribution and Use**

Brazil's energy market is the largest in Latin America, the 6<sup>th</sup> largest consumer in the world, and has the 7<sup>th</sup> largest electricity generation capacity worldwide (U.S. Department of Commerce, 2023). Rio de Janeiro plays a significant role in this impressive profile. With its strategic location and robust infrastructure, the city is a central hub for oil and gas exploration and production, boasting the presence of major facilities and headquarters of industry giants, including Petrobras.

This prominence in the oil sector contributes significantly to Brazil's overall energy success. Brazil is the largest petroleum producer in South America and the 9<sup>th</sup> largest in the world. (U.S. Energy Information Administration, 2023)

Additionally, Rio de Janeiro has been a powerhouse in hydroelectric power generation, with notable facilities contributing substantially to the country's electricity grid near the state's border. As Brazil continues to evolve in its pursuit of sustainable energy, Rio remains at the forefront of this transition, actively engaging in the development of renewable energy sources such as wind and solar power. The city not only amplifies Brazil's status as a regional energy leader but also reflects the dynamic and diversified nature of the nation's energy landscape.

The status of Brazil as a worldwide oil producer is not reflected in the country's consumption trends. Hydropower has been the leading source of energy consumption in Brazil for decades (U.S. Department of Commerce, 2023). Rio experiences a dynamic energy landscape shaped by its vibrant urban life, contributing to a significant amount of consumption in Brazil. This is notably influenced by the city's dense population and rapid development.

#### 4.5. Challenges within Rio's Energy Sector

Embedded in Rio's intricate energy landscape are challenges that stem from their significant reliance on hydropower, persistent transmission losses, and glaring disparities in energy distribution. The city's overreliance on hydropower renders it susceptible to fluctuating water levels and the overarching impacts of climate variability related to draughts and deforestation. This situation is a major factor in the country's transmission losses. Due to inadequate transmission and distribution networks, favelas, the informal settlements in Rio, often experience energy loss and limited access to reliable energy sources (Leme, 2021). This also causes the existence of illegal connections, something that affects the entirety of Rio, both formal and informal settlements.

### 5. Transportation

#### 5.1. Introduction to Transportation in Rio de Janeiro

There are approximately 6.3 million people that inhabit Rio de Janeiro (Largest Cities in Brazil 2022/Statista, 2023). With such a large population, it is necessary to have well-planned transportation options for the citizens to move about the city efficiently. To enable the population to move around Rio, there are 10 main transportation modes. They include cable cars, ferries, bus rapid transit, municipal vans, automobiles, trams, public buses, the metro, urban trains, and air services. While there are also social issues and inequalities that plague these different modes of transportation, potential solutions for the major transportation issues of Rio de Janeiro exist.

#### 5.2. Cable Cars

The cable cars were introduced in Rio de Janeiro in 1912 (Halais, 2019). Since

then, the cable car has made countless trips taking millions of locals and tourists up and down various mountains (Johnson, 2015a). The city inaugurated a new cable car system in 2011, which linked the suburban train network with the massive *Complexo de Alemão* favela (Johnson, 2015a). The cable cars were operated by an electrical current, meaning that they were environmentally friendly (*Cable Cars—The Eco-friendly Way to Take People to Mountaintops*, n.d.), which has become extremely important due to the increasing number of residents in the city. There were 6 stations connecting the hilly, hard to access neighborhood residents to Rio's main train network (Halais, 2019). The fares were reasonable and cheaper than the city's Metro. This affordable connection gave adults in the local favelas access to the bigger and less expensive supermarkets that are located downhill. The cable cars have since been closed, and the sole cable car in Rio de Janeiro that is still operating serves only tourists hoping to see the views from Sugarloaf Mountain. There were previously 6 different routes and 5 of them served the residents of the favelas.

### 5.3. Ferries

There are 4 ferry routes that operate from the Praça XV ferry terminal, which is located a short walk from Carioca Station on Metro Line 2. These modern ferries serve a couple of islands in Guanabara Bay as well as Niterói on the opposite side of the bay. It is not uncommon for the people in Niterói to commute to work using the ferry. The ferries are considered a safe mode of transport in Rio, and tourists utilize them at night. The ferries are used quite often since they are commuter transit, and they carry on average 30,000,000 people annually. It is apparent that these ferries are well used and an important part of everyday transportation for the residents of Rio de Janeiro.

### 5.4. Bus Rapid Transit

Rio's Bus Rapid Transit (BRT) opened in 2012, and it covers 56 kilometers and has 53 stations. The BRT services are a mixture of non-stop, limited stops, express, and all stops, and the stations are categorized by their level of service. Terminals are served by most passing buses, and express stations are served by many limited stop and express services, as well as all-stop services. All stop stations are typically served by buses stopping at all stops. There are clearly defined corridors in Rio de Janeiro. The BRT carries about 100,000 passengers per day, and it has been reported that 15% of them had not taken the bus previously to the BRT system being installed. The system is modern, clean, fast, and efficient. However, poor management and maintenance let the system decay. By 2020, there were about 121 buses of the 400 buses that were not road worthy, and this had a major effect on service. To fix the BRT system, the municipality bought 561 new BRT buses, not only replacing the fleet, but increasing the size of the fleet by 161 buses. They also renovated all the stations to include new doors, new lighting, and electrical upgrades. The municipality went even further and com-

pletely rebranded the system. All the buses are now yellow and gray, and the new colors give the system a modern look.

### 5.5. Municipal Vans

This informal, non-regulated transportation system comprises a variety of services ranging from moto-taxis to vans. This mode of transport is used for both neighborhood circulation and suburb to center line haul services. In dozens of cities across Brazil, rising unemployment, worsening congestion, and rising public transit fares have combined to set off an explosion of informal public transit activity using moto-taxis and vans (Golub, 2003). The locals credit the rise in informal vans around the year 1995 to the declining quality of bus services. These vans and moto-taxis have a large number of routes. Due to the small size of the vans, they are able to penetrate the narrow street network of favelas producing a broader, thinner, and more diverse transportation network.

### 5.6. Trams

Rio de Janeiro has two different streetcar systems. The first streetcar system operates around the Santa Teresa neighborhood, and it is one of the oldest systems in the world. It has been operating continuously since 1819, with the exception of four years between 2011 and 2016. The system is primarily ridden by tourists who want to ride a historic streetcar.

The second system is a modern streetcar system that operates around the center of Rio de Janeiro. The system was implemented to support the influx of people that would be entering the country for the 2016 Olympics, which was to be hosted on the outskirts of the city. The system is comprised of 3 different lines.

The streetcar system added to downtown Rio de Janeiro's urbanism. When the streetcar tracks were built, it increased the number of trees and greenery in the city center. The trees that were added provided tree canopy areas that helped shade the residents of Rio and improved the air quality in the city overall. Areas of the streetcar tracks are tree-lined, and it is a common site in downtown Rio. In addition to the positive environmental impacts of this streetcar project, the streetcar system has also been credited for alleviating bus congestion in the city. (Editorial, UTM, 2022).

### 5.7. Public Buses

Buses are the main form of transportation in Rio de Janeiro. They are the most common way for people to get around the city. Buses are a critical part of Rio's transport system. They provide neighborhood level service to areas of the city that do not have rail service. The buses connect different neighborhoods with the rail stations and then to the broader transportation network. Rio's public buses are operated by 41 private bus companies, and they are a critical part of Rio's transportation system.

However, the congestion and crime have resulted in the bus system becoming

a last resort in terms of transportation options. To combat this, revitalizing and rebranding the bus system should be a priority. This could be done by adding a dedicated bus lane or signal priority. This would increase the speed of buses and increase transportation equity, and improvements like this can be made with little capital investment. The city would only need to repaint the lines on the street. However, these buses are not great for the environment. Transit authorities around the world are upgrading their buses to electric systems, but these buses are expensive and do little to help the environment if the power is being produced by nonrenewable sources. A cost-efficient solution would be to upgrade the buses to compressed natural gas or CNG.

### 5.8. Metro

Rio de Janeiro has a state-of-the-art Metro system. The system is comprised of 3 lines, 41 stations, and 51 kilometers of track. The first Metro line began operation in 1979 with the opening of Line 1. This line serves central Rio as well as the southern and northern areas of the city. The line connects several tourist attractions and high-density neighborhoods. It is heavily utilized by locals and tourists. The second line opened in 1981 as Line 2. Most of Line 2 follows Line 1 until it hits the central train station where it branches off to serve Uruguai. This line serves downtown and many working-class neighborhoods surrounding the downtown epicenter, and it is predominantly used by locals. Line 3 was opened in 2016 before the Olympics. This line was built entirely for the Olympic Games. The line serves 5 stations in the northern section of the city. One of the stations is located at Brazil's largest favela, Rocinha.

### 5.9. Urban Train

The urban rail system is the backbone of Rio de Janeiro's transportation system. All the different modes of transportation connect with the urban rail system. The urban rail system provides regional service around the city of Rio. It is vital in connecting predominantly low-income workers to higher-paying jobs in central Rio. The urban rail system is comprised of 104 stations, 270 kilometers of track, and 8 lines. Five of the train lines begin on the edge of the city and go into Rio's central train station downtown. There are 3 branch lines that serve areas along the edge of the city (*About Us/Supervia, n.d.*). These branch lines serve predominantly low-income communities around the outside of the city. There are 5 mainline trains that serve Rio's central train station. These lines provide a mix of local and express service. Several of the rail rights-of-way consist of 4 tracks, making the possibility of express and local train service a reality. The combination of local and express train service makes riding a train from the central train station to the suburbs fast and efficient. The urban rail system is used by locals on their commute to work. The trains provide a vital link between the high-paying jobs in the city and the predominantly low-income suburbs.

Even though the urban rail system is a critical part of Rio de Janeiro's public

transport system, it is one of the most underinvested forms of transportation. This underinvestment is reflected in the system's infrastructure.

### 5.10. Air Service Connections

Rio de Janeiro is well connected to air services. There are 3 airports in the city, with the largest being the *Aeroporto Internacional of Rio de Janeiro*. The airport has limited international flights to Europe, America, and the Middle East. To compare flights from Rio's international airport to São Paulo international airport, Rio does not have as many international flights. This is noticeable in the North American market, São Paulo has about 17 flights a day to North America while Rio has about 3 (Flightradar, n.d.). For the airport to continue expanding, it will need to increase the number of international flights. The airport is connected to the city by a BRT line. The second airport is the *Aeroporto Santos Dumont*, which is Rio's city airport. It provides domestic flights around Brazil, mostly to São Paulo. Flights from São Paulo operate frequently, similar to a bus line. The São Paulo route provides an essential connection between the capital city and Rio. The third airport in Rio is the *Aeroporto de Jacarepaguá*. This airport is located next to the Olympic complex. It was opened in 1927 but renovated before the Olympics in 2007. Currently, the airport operates a large private aviation complex as well as a single commercial flight route to São Paulo.

### 5.11. Social Issues

There are many social issues that plague the transportation systems in Rio de Janeiro. The ones that are the most influential in Rio are poverty, discrimination, and violence. When comparing the Metro and urban railway, the Metro in Rio is far better than the urban railway. The Metro is clean and frequent, while the urban railway is dirty and infrequent. The Metro is predominantly used by wealthy people and tourists, while the urban train system is predominantly used by poorer people. The urban trains lack air conditioning, meaning that the poorer residents in the city are subjected to uncomfortable conditions on their commute to work. There is also a lack of pedestrian bridges across the Metro, urban railway, and highway. This means that the residents living in these areas have to walk long distances to cross their right of way. The city bus system in Rio has many social issues as well, specifically in terms of discrimination against the lower classes. The city of Rio has been known to change bus routes during large events to make it harder for poorer residents to access the beach. According to residents, riding Rio's city bus can be dangerous, especially at night. The buses are a hotspot for pickpockets, and the city buses run through the favelas which have been known to be incredibly dangerous.

The bus rapid transit system has flaws of its own. The construction of the BRT lines led to the eviction and displacement of entire communities. It is estimated that a total of at least 10,000 homes, businesses, and public spaces were forcibly removed. The people who were displaced now deal with much longer commutes

for a project for which the intended objective was to improve urban mobility (Johnson, 2015b). Thus, there are a vast number of social issues regarding Rio's bus systems.

The different modes of transportation in Rio de Janeiro are flawed, and while there are a few that are getting better, most of them still have many improvements that need to be prioritized to protect the health and safety of the citizens.

## 6. Waste and Solid Waste

### 6.1. Introduction

The longstanding sanitation issues facing many communities in Rio de Janeiro are an abysmal and inhumane aspect of life that have contributed to high mortality rates (Coelho-Netto et al., 2007; Comissão Nacional Sobre Determinantes Sociais da Saúde, 2008), and which continue to threaten the public's health and wellbeing. These issues originate from the lack of initiatives and policy support from the government, the general public's ignorance regarding the effects of an individual's actions, and the lack of education on how to change normalized behaviors and culturally accepted habits. "Rio de Janeiro, the second largest city in Brazil and the third largest metropolitan area in South America, has over 6.3 million inhabitants, approximately 22% of whom live in slums." (EPA, n.d.). It has been noted previously in this article that favelas are slums, with the term slum being defined by Cities Alliance as "...used to describe informal settlements within cities that have inadequate housing and squalid, miserable living conditions. They are often overcrowded, with many people crammed into very small living spaces."

Rio de Janeiro has continuously failed its people, and its government has made endless promises that are never fulfilled. Most favelas lack basic municipal services such as clean water, sanitation, waste collection, storm drainage, street lighting, paved sidewalks, and proper roads for emergency access (Cities Alliance, n.d.). Due to the direct deposit of tons of solid waste and raw sewage into the waterways daily, many of the natural tributaries sprawling into the Guanabara Bay are considered biologically dead. As a result of these prolonged practices, many families are left with no choice but to interact with these biologically dead and infested waters. These contaminated waters have been linked to thousands of gastrointestinal illnesses and deaths. "The lack of sanitary conditions and sewage treatment system in the poorest areas around Guanabara Bay, e.g., Duque de Caxias area, is directly reflected in infant mortality, which reaches 23.9%, contrasting with the areas served by the sewage system, where the infant mortality is 4%." (Coelho-Netto, 2007; Comissão Nacional Sobre Determinantes Sociais da Saúde, 2008). Unfortunately, this issue is not unfamiliar to those living in Rio de Janeiro.

### 6.2. Background

As mentioned above, Rio de Janeiro is one of the most densely populated areas

in South America. Rio has immense disparities in its social classes with the richest few having full access to amenities and services, while living right next to the poorer majority who have no access to basic amenities or services. “One in three of the more than 10 million inhabitants of the greater metropolitan area live in places that have no connection to a sewerage system, and only about half of the city’s waste is treated before entering waterways and eventually the ocean.” (Vidal, 2016). It is estimated that Rio de Janeiro generates approximately 3.5 million metric tons of solid waste annually. The waste produced per capita is approximately 1.6 kilograms per person per day (EPA, n.d.).

Rio de Janeiro has undergone multiple attempts to clean up the bay and find new ways to manage sewage and solid waste. However, clearly these efforts have failed to continually involve and support the poor majority of the city’s population. In 1994, Rio de Janeiro launched a US\$ 1.2 billion clean-up program for sewage, but failed to connect pipes to all areas. Rio was also the host of the 2016 Olympics, which put international attention and pressure on the city to clean up its waterways and provide these basic services to all of its inhabitants. However, even after acquiring nearly US\$ 1 billion to clean its waters, the project ended in insolvency and the continuous pollution of these water bodies (France 24, 2022; AFP). Through the analysis of past legislative and community-based actions, the best approach is to focus on the individual and community levels with education being the focal point. These issues can be approached by attempting to decrease the quantity of pollutants entering the waterways before they reach the water.

### 6.3. Priorities

It is clearly necessary to educate and create awareness of individual and community actions that can be taken in favelas to decrease the amount of raw sewage, waste, and other heavy metals being dumped into water bodies in the surrounding area. This approach is being implemented at the individual and community levels to provide a bottom-up perspective on these issues. These at-risk communities have been prioritized, and it is proposed here to invest in education programs and adopt policy changes to help make these actions achievable, as well as secure the longevity of these programs. Adding new amenities and programs to these areas will provide more job security for the community, while simultaneously creating a greater sense of community, ownership of the physical and non-physical aspects of the neighborhood, and agency to create change. These upgrades to communities will respect their cultural norms and create jobs within the favelas, however, these improvements could also create more pressure on transportation that would limit residents from access to healthcare, jobs, and schools, and this must also be considered.

### 6.4. Wastewater & Solid Waste Conclusions

Given the analysis of current conditions regarding the sewage and solid waste in Rio de Janeiro, especially in its favelas, individual and community-based actions

are suggested to help resolve some of these issues. These objectives are primarily focused on providing access to adequate education and sanitation supplies for all who reside in Rio de Janeiro. Through analysis, it is argued that these issues are fundamentally institutional, with inadequate policy and insufficient government support being the main components of failure. The likelihood of overcoming these challenges depends on social change and finding ways to have interdisciplinary work within the city and other agencies.

Since the objective here is working to reduce the amount of wastewater & solid waste that is entering the waterways, there is a need to continue to clean the waters and remove trash and heavy metals on a regular basis. Through this, it is suggested to continue working with Eco-Boats. Once the trash is collected, [de Abreu et al. \(2017\)](#) suggest the reuse of sewage sludge in agriculture.

The agricultural panorama of Rio de Janeiro State is favorable for agricultural recycling of sewage sludge since there is great potential demand for this residue and, among the 10 agricultural crops with the largest cultivated area in the state, sludge can be used as fertilizer or soil supplement in 8 of them. The implementation of a State Sewage Sludge Recycling Program could dispose of this material in a more sustainable way, as well as improve the quality of agricultural soils and reduce costs with chemical fertilizers, bringing positive results for sanitation companies and producers.

## 7. Water

### 7.1. Background

After becoming the capital of the State of Brazil in 1763, the City of Rio de Janeiro saw tremendous growth very quickly. Unfortunately, only infrastructure for the wealthy was prioritized, and very few large-scale public works projects were ever enacted. From the beginning, water access has been one of those neglected infrastructure investments that was never successfully implemented. As the city continued to grow into a notable international megacity, the inequality between those who could afford the most basic resources and those who could not, was only exacerbated.

Throughout Rio's history, there are examples of previously attempted laws and policies which fell very short of any significant progress. An example is the 1934 Brazilian Water Code, which was enacted to manage water resources but failed to provide an effective model to deal with the decentralized, participatory management system that had been in place ([ANA & OECD, 2022](#)). With a lack of enforcement from city, state, and national agencies, any attempts at alleviating water stress, water use conflict, and pollution were fruitless. 1997 saw the passage of The Water Law, which came after decades of criticism and public debates. In 2000, the National Water Agency (ANA) was established to implement a national resource management system targeted at nationalizing water access and good governance ([Slater, 2019](#)). However, despite all the attempts at implementing new rules and regulations, concerning issues remain.

With a lack of funding for any sort of water infrastructure projects, it is only more evident that little of what is put on paper is translated into action. Execution and management of laws and policies are broken, prone to delays and corruption, and at the mercy of short-term political agendas.

The overall irony of the situation in Rio de Janeiro concerning water access is that not only is there plenty of water potentially available, but the city was one of the first to institute a water charge system in the country. All the conditions and infrastructure are in place for water charges to successfully achieve their intended purpose and substantiate the whole process, but it has yet to be successfully tackled.

## 7.2. Water Resources and Limitations

Brazil is a water rich country, with some estimates saying it holds as much as 15% of the world's fresh water supply (Ibid.). Much of the water is located within the Amazon basin in the northwestern part of the country. The southwestern region where Rio is located is a drier part of the country but, located on the Atlantic, which opens into Guanabara Bay and is fed by numerous in-land rivers, there is no shortage of potentially available water. The difficulty is that the ocean water requires very energy intensive desalination processes that are currently out of the scope of Rio's water access plans and possibilities. As a result, the entirety of the Metropolitan Region of Rio de Janeiro (RMRJ) pulls from in-land surface waters.

## 7.3. Water Justice

The severity of the water problem in Rio de Janeiro's favelas is evident. There is a lack of clean, dependable water sources, which has an impact on daily living and hygiene. 16.9% of locals report that they have water shortages at least twice a week. 26% of people who have their water supply cut off go more than 24 hours without any water. 42.5% of the population was badly affected by the water shortage, as they were unable to meet their basic hygiene demands at the height of the COVID-19 pandemic (Energy and Water Justice in the Favelas, 2023).

Not only is access an issue, but many locals are also worried about the quality of the water. 31.34% of people drink tap water without filtering it, even though 25% say they frequently find the taste off, and 30% notice a tint that could be an indication of pollution. The problem is made worse by flooding and inadequate sanitation. A significant 74.5% reported that they frequently see leaky pipes in neighborhood streets. It is concerning to see that 80.1% of families have observed an increase in floods in recent years, with 51.5% of them being impacted by flooding during the rainy season (Ibid.). These circumstances show how urgently Rio's favelas need to improve their water management and infrastructure so that every inhabitant has fair access to reliable and safe water.

Access to clean, potable water is a fundamental need for everyone. Regardless of the formality of the place where people live, water insecurity does not need to

be as critical an issue as it currently is, and there is evidence that by 2035, if water sources, both natural and artificially supplied, continue to be ineffective at meeting the demands of the ever-growing population, an estimated 92% of the populous will be at a higher risk for water insecurity (ANA & OECD, 2022). The city of Rio has the resources to ensure that its population has that access. Problems persist, but diligent action that is true to its mission can easily solve this rudimentary issue. Water justice is a fight for everyone to have clean water for drinking, cooking, and hygiene, and it is a necessary fight that must be pursued. Overall, there is a huge lack of public action to demand and realize the right to water. As complacency on all sides has prevailed, the primary function here is to educate, inform, and inspire others to take on this fight for justice so all citizens, living in favelas or not, can have proper access to water.

## **8. Finance**

### **8.1. The City's Financial Standing**

The City of Rio de Janeiro exists within a federalized government system where power is divided among national (federal), state, and local governments. This is traditionally a hierarchical relationship where policies, initiatives, and resources move up or down through the state level. The City of Rio de Janeiro, however, has grown enough in both population and economic power to justify a direct relationship between itself and the national government on the federal level (bypassing the state level). While this does cause some friction between the administrations of the State of Rio de Janeiro and the City of Rio de Janeiro, it gives the City of Rio de Janeiro the ability to compete with larger state entities for the attention of national and international funding agencies.

### **8.2. The City's Credit Rating**

According to Fitch Ratings, an award-winning provider of credit ratings, commentary, and research, the City of Rio de Janeiro received a B+ as a long-term issuer default rating in August of 2023. This rating classifies the city as “highly speculative,” indicating the city is meeting all current financial commitments, but it is at risk of failing on these payments if the business or financial market deteriorates.

With its credit rating, Rio has access to the bond market, which is the largest and most important of the global financial markets, valued at US\$ 128.3 trillion dollars in August 2020. Bonds are a financial security (agreement) where financial investors grant funds to a government, company, or financial institution in return for the promised prepayment of both the principal amount and accumulated interest. This is similar to a private individual taking a loan from a bank, but larger in scale, and funding can come from multiple parties.

### **8.3. Financial Systems Available to the City**

Existing within a federal government system, the City of Rio de Janeiro can ap-

ply for project funding from various levels of government (local, state, national) depending on the scale and nature of the project in question. The following is a non-exhaustive list of entities/tools that Rio can access for project funding, collaboration, and professional expertise.

#### **8.4. Brazilian National Development Bank (BNDES)**

By far the largest and most utilized financial entity within the country of Brazil, the Brazilian National Bank (BNDES) is a state-owned bank belonging to the Brazilian national government. BNDES is an all-encompassing and powerful financial tool of the Brazilian government, operating at all levels of government and representing Brazilian interests on the global stage. Most capital projects carried out in Brazil are handled in one form or another by BNDES, operating both under the directives of the federal government and as a lending institution receiving applications for funding daily. As a financial institution, BNDES is considered one of the safest financial institutions within the nation of Brazil

#### **8.5. Special Agency for Industrial Financing (FINAME)**

A specialized subsidiary of the Brazilian National Development Bank, FINAME focuses dedicated financial resources on the purchase and sale of heavy machinery for the Brazilian economy.

#### **8.6. BNDES Participações S.A. (BNDESPAR)**

A specialized subsidiary of the Brazilian National Development Bank, BNDESPAR is a business corporation operating within BNDES that abides by its policies. Its role is to invest BNDES capital assets with private market partners to grow financial assets.

#### **8.7. Ministry of Integration and Regional Development**

Initially established in 1999, the Ministry of Integration and Regional Development was reformed in 2023 after a brief period combined with the Ministry of Natural Integration and the Ministry of Cities. Formed to build connections between Brazil's various governmental bodies and regions, the ministry is more of a policy and oversight organization.

#### **8.8. Ministry of Cities**

Formed under President Luiz Inácio Lula da Silva in 2001 to address congestion in Brazil's megacities, the program focused on the transportation and housing needs of citizens. Enjoying popular support due to the social programs aimed at supporting the urban poor in the favelas, the ministry was absorbed into the Ministry of Regional Development in 2019. Described as a step toward efficiency to combine transportation, social programs, housing, and other urban aspects under one umbrella, the organization soon encountered problems due to competing interests. The Ministry of Cities was re-

formed as a dedicated ministry in 2023 following the election victory of President Luiz Inácio Lula da Silva.

### **8.9. Investment Partnership Program (PPI)**

The Investment Partnership Program (PPI) was created in 2016 with the goal of strengthening the interaction between the State and the private sector through the signing of partnership contracts (Investment Partnership Program (PPI)). It is a way to get important projects a large amount of private attention and investment. The PPI meets with the President of Brazil giving the selected projects a high level of attention.

### **8.10. Brazilian Savings and Loan System**

Brazil also has a system of tax-free savings deposits in banks, known as SBPE (*Sistema Brasileiro de Poupança e Empréstimo*, the Brazilian savings and loan system). Banks are required to use part of these SBPE deposits for mortgage loans at a set rate over a special inflation index.

### **8.11. Savings and Loan Associations (APE) (Part of SBPE)**

Savings and Loans Associations (APE) are institutions created to facilitate house financing and to encourage savings. The APE's members can contract real estate financing or deposit their savings. The APE's are part of the Brazilian Savings and Loan System (SBPE), and their active credit operations are mostly directed to the real estate market, including the Housing Financial System (SFH).

### **8.12. Housing Financial System (SFH)**

According to UN Habitat, "The real estate credit system used in Brazil for residential housing (known as the Housing Finance System-SFH), was created in 1964. Previously, there was no organized system for housing financing in Brazil" (HABITAT, 2016).

### **8.13. Brazil Investment Forum (BIF)**

The Brazil Investment Forum is a forum that is held to attract investment in Brazil. "BIF is the result of a partnership among the Brazilian Federal Government, the Inter-American Development Bank (IDB), and ApexBrasil" (Brazil Investment Forum 2023, n.d.).

### **8.14. Inter-American Development Bank (IDB)**

The IDB is the main source of development financing for Latin America and the Caribbean. According to their "Who We Are" page, the bank "work[s] to improve the quality of life of millions of people in our 26 borrowing countries. We have 48 member countries" (Inter-American Development Bank (IDB), n.d.).

They work in 6 priority areas to achieve their goals of promoting sustainable

growth and reducing poverty and inequality. Those priority areas are social inclusion and equality, productivity and innovation, economic integration, gender equality and diversity, climate change and sustainability, and institutional capacity and the rule of law (IDB).

### **8.15. Brazilian Trade and Investment Promotion Agency (ApexBrasil)**

According to the World Economic Forum, “The Brazilian Trade and Investment Promotion Agency (Apex-Brasil) works to promote Brazilian products and services abroad and to attract foreign direct investment to strategic sectors of the Brazilian economy.”

### **8.16. Funding Authority for Studies and Projects (FINEP)**

FINEP’s mission is “To promote Brazil’s economic and social development through public funding for Science, Technology and Innovation at companies, universities, technological institutes and other public or private institutions (FINEP).”

### **8.17. Finance Project Proposal**

The Finance Team’s project proposal is to establish a *Sovereign Wealth Fund (SWF)* for the City of Rio de Janeiro to fund the stabilization and development of local favelas. Given the city’s limited geographic size and limited mineral extraction opportunities, identified seed funding will be a 1% profit tax on all refined material produced by the Rio de Janeiro II coking refinery. These annually collected funds will then be invested in international and domestic markets, with investment returns being used to finance capital projects or short-term program funding. Theoretically, this will continually grow the city’s SWF total funding capacity while removing the bureaucratic process and congestion that comes with working with local government.

### **8.18. Restrictions**

Generated income should only be used to fund capital improvement projects, and not used as a primary source for operating funds. Exceptions to this include funding for a single year of operating costs for pilot programs to explore feasibility, but they are not permitted for repeated distribution.

Accepted funding requests should be limited to recognized favelas within the Rio de Janeiro municipal boundary. These capital projects should be intended to provide key living necessities to local neighborhoods and/or improve residents’ quality of life.

### **8.19. Potential to Scale-UP**

Once the pilot project proves successful and establishes a stable funding stream, the tax income received by the SWF can be broadened and applied to all re-

source extraction/refining companies within the Rio de Janeiro municipal boundary. This can be applied incrementally based on a resource if desired.

## **8.20. Financial Implementation of Projects**

The Finance Team received project proposals with requests for funding from 4 of the 6 other teams. They were Energy, Poverty Alleviation, Transportation, and Wastewater & Solid Waste. In total, the Finance Team received 6 proposals, with 2 coming from each of the Transportation and Wastewater & Solid Waste Teams.

Using the analysis of different potential funding sources, the Finance Team suggested possible sources of funding for the proposed projects.

## **8.21. Sources of Funds for Proposed Projects**

### **8.21.1. Energy**

Beginning with the Energy Team's project with a total cost of US\$ 57,000, the Finance Team proposes that it be funded by the Inter-American Development Bank because it aligns with their goals of sustainable development while reducing inequality and poverty. In addition, the project cost is low enough that the IDB should be able to fund it entirely.

### **8.21.2. Poverty Alleviation**

The Poverty Alleviation Team's project has a total cost of US\$ 780,000 and would involve promoting urban agriculture in Rio's favelas. The Finance Team proposes that the project be split evenly between the Brazilian National Development Bank and the Savings and Loans Associations. The 2 entities would be interested in the project due to their goals of making housing in favelas more stable and permanent aligning with the project's outcomes. In addition, the Ministry of Integration and Regional Development as well as the Funding Authority for Studies and Projects, would be involved by providing planning assistance to the project.

### **8.21.3. Transportation**

The Urban Rail Improvement Project, the first of 2 proposed projects from the Transportation Team, is the largest of the 6 projects. With a cost of US\$ 1.2 billion, the project will need to be funded through multiple sources. Similar to the previous round of improvements to the Urban Rail System in 2013, the project is suggested to be funded by both the State of Rio de Janeiro and the Brazilian National Development Bank. The Finance Team also proposes that the Investment Partnership Program become part of the funding coalition as this project would have the potential to attract foreign investment and be truly transformative for the City of Rio de Janeiro and, therefore, Brazil. The Brazilian National Development Bank would provide funding for 50% of the project cost, while the State of Rio de Janeiro and the Investment Partnership Program would provide 20% and 30% respectively. Finally, the Ministry of Integration and Regional Development

opment would provide planning assistance.

The Transportation Team's second project, the Cable Car Restoration, has a project cost of US\$ 110 million. The Finance Team proposes that, like the Urban Rail Improvement Project, the funding for this project be provided by 3 different actors. The Brazilian National Development Bank would provide 50%, the Ministry of Cities would provide 30%, and the State of Rio de Janeiro would provide the final 20%.

#### 8.21.4. Wastewater & Solid Waste

Moving onto the two projects from the Wastewater & Solid Waste Team, their first project, Trash Collection in Favelas, has a cost of US\$ 85,942. Due to the low cost and the project fulfilling many goals of the Inter-American Development Bank, the Finance Team proposes that the IDB provide 100% of the funds.

Finally, the Wastewater & Solid Waste Team's second project, titled Sanitation Stations in Favelas, has a project cost of US\$ 4.35 million. The Finance Team proposes that the cost be split evenly between the Inter-American Development Bank and the Funding Authority for Studies and Projects due to this project matching these 2 agencies' development goals.

### 9. Concluding Remarks

The intent of this project was to bring the contemporary thinking and practice of Urban Environmental Management to the solution of real problems in Rio de Janeiro, Brazil, a very large cosmopolitan South American city best known for its gorgeous natural settings, Carnival, samba, bossa nova, and balneario beaches such as Barra da Tijuca, Copacabana, Ipanema, and Leblon. In addition to the beaches, some of the most famous landmarks include the giant Statue of Christ the Redeemer atop Corcovado Mountain, named 1 of the 7 wonders of the world, and prominent in tourist brochures. Others are Sugarloaf Mountain with its cable car, a relic from the 2016 Summer Olympics, and Maracanã Stadium, one of the world's largest football stadiums. Despite its breathtaking sites and natural beauty, it is a city plagued by numerous serious environmental problems.

As stated in the Introduction to this article, the objective of this study was to replicate as much as possible the conditions under which a team of expatriate consultants would operate in this context so that they could develop ideas and procedures that fit the circumstances they would likely confront as professional planners working on such projects for international development banks or the multilateral donors in the United Nations system, as well as the numerous bilateral donors of the developed countries (Edelman, 2023). Major countries include the United States, Japan, Canada, Australia, the United Kingdom, Germany, France, the Netherlands, Belgium, Switzerland, Sweden, Denmark, Norway, Finland, Italy, and Spain (Edelman, 2020). Consulting firms operating internationally on projects these institutions, agencies and countries fund come not only from the donor countries named, but increasingly from countries such as India,

China, South Korea and Brazil itself, and the staffs of experts they provide often come from a number of the countries named (Edelman, 2014; Edelman, 2018).

In this working environment, it was instructive for the students to formulate a 5-year plan of solutions to the environmental problems and issues they faced rather than be told how to deal with them (Edelman, 2022). This expanded their analytical skills and taught them how to utilize the limited knowledge and resources available to come up with implementable solutions for the benefit of the people of Rio. They learned that such skills are transferable to other projects, and they gained a greater appreciation of the skill set that they are developing as planners (Edelman, 2016). Bringing the reality of development to the classroom, and asking students to confront it, gives them an appreciation of professional practice that the study of theory alone does not (Edelman, 2015). Consequently, this project has attempted not only to expand the education of graduate students, but also to provide a meaningful contribution to planning pedagogy (Edelman, 2019).

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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