TRANSPORT GLOBAL PRACTICE

Toward Efficient, Sustainable and Safe Urban Transport in Madagascar

Antananarivo and Other Major Cities

Synthesis Report

WORLD BANK GROUP
PPIAF Enabling Infrastructure Investment
MOLO Mobility & Logistics

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Acknowledgements

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Executive Summary

Background. Madagascar remains to exploit agglomeration economies and urbanization economies to sustain more rigorous economic growth. After several political and economic crises, Madagascar restored its modest but steady growth path with an average growth rate of 3.5 percent in the last 5 years (before the COVID-19 pandemic). Yet, the country's performance remains less favorably compared with other countries in the region. Poverty is persistently high in Madagascar, with a large spatial disparity in poverty incidence across areas. The vast majority of rural residents – about 80 percent – remain poor. Urban poverty is relatively modest but is also an important challenge for Madagascar. The urban poor is particularly vulnerable to external shocks, such as COVID19. The pandemic is likely to reverse more than a decade of gains in poverty reduction in Madagascar.

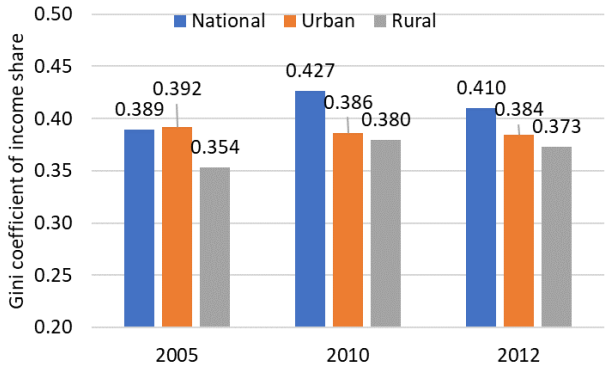
In Madagascar, opportunities are unevenly distributed particularly in urban areas. In the early 2010s, the Gini coefficient was close to 0.4, among the highest in developing countries. According to the latest household survey in Antananarivo in 2016, the Gini coefficient of household income is even higher at 0.452.

Job opportunities may exist, especially in Greater Antananarivo where about 60 percent of formal enterprises are concentrated, but it is the inefficient and unreliable public transport services that restrict access to such opportunities. People are missing better paid employment opportunities. Firms are also missing opportunities to hire better skilled workers.

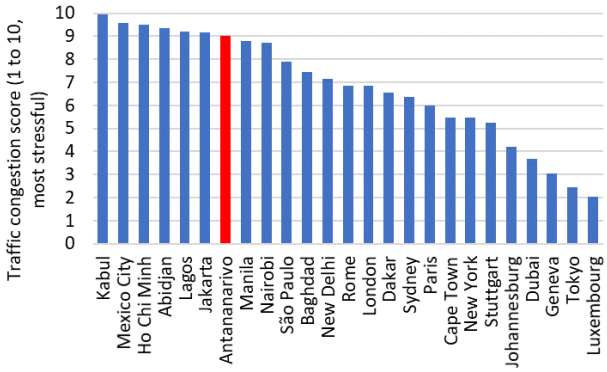
The economic costs of inaction are significant. According to the Global Least & Most Stressful Cities Ranking, Antananarivo's traffic congestion is ranked 134th of 150 major cities in the world. In Antananarivo alone, the economy is estimated to lose about US$40 million or 0.34 percent of GDP every year, because of traffic congestion. In relative terms, this is almost comparable to the economic losses that the United States suffered because of traffic congestion in 2018 (i.e., US$87 billion or 0.4 percent of GDP).

The Government of Madagascar has embarked upon several major urban transport programs, potentially spending hundreds of millions of dollars, however, these investments tend to be fragmented and less coordinated. Their economic validity remains to be confirmed under a more solid, evidence-based project appraisal framework. Strong public governance in planning, allocating and implementing infrastructure investment is called for, which not only improves fiscal efficiency and sustainability but also stimulates macroeconomic stability and economic growth.

Gini Coefficients in Madagascar



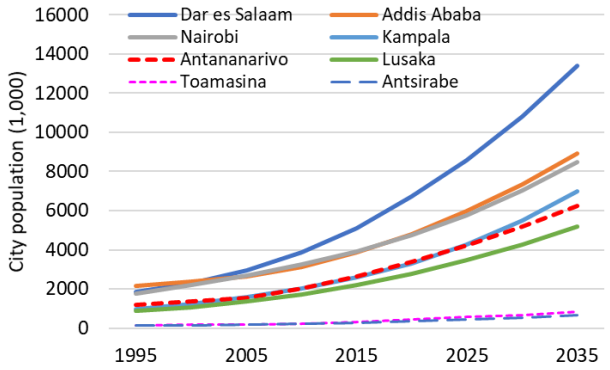
Traffic Congestion Scores in Selected Cities



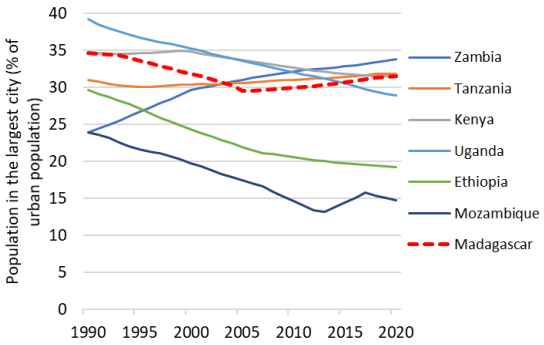
Objectives. Given the above background, this report aims to (i) review the trends of urban transport developments in major cities in Madagascar, (ii) analyze the present and future demand for urban mobility with focus on Greater Antananarivo, (iii) review the current public infrastructure governance in the urban transport sector, comparing the government's urban transport programs and other complementary interventions, to maximize the synergy among the programs, and (iv) provide high priority policy recommendations.

Urbanization trends. Madagascar has been experiencing rapid urbanization in recent years. Antananarivo, the primary city in the country, continues growing vigorously with a total population of 3.3 million, which would be doubled to 6.2 million by 2035. Secondary cities, such as Toamasina and Mahajanga, are also growing, however, Antananarivo remains predominant. Half of the country's urban population lives in Greater Antananarivo. Other secondary cities are less than one-tenth by population size. Unlike other African countries, the primary city ratio in Madagascar is increasing. It means that access to Antananarivo is important for everyone in the country. Although Antananarivo is already crowded, it attracts even more people and firms, bringing in more traffic.

Urban Population in Selected Cities



Share of Population in the Largest City



Lack of urban transport infrastructure. Antananarivo is extremely congested because of the lack of implementation of land use and urban development plans as well as the poorly managed public transport systems. From the land management point of view, the space dedicated to transport infrastructure is generally limited in Malagasy cities. Antananarivo and Toamasina are estimated to use only about 5 percent of urban areas for roads, far below the global norm of 15 to 25 percent. This is partly because of the topographic conditions (e.g., a hilly background around Antananarivo) but mostly because of the weak implementation of urban land management. For instance, the law governing the right of way was updated in 2015, however, the enforcement is still a challenge.

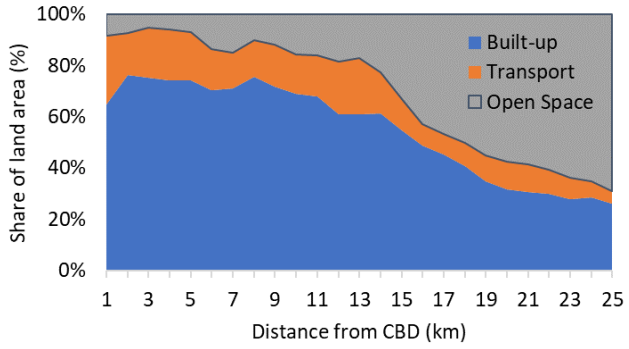
Limited mobility, particularly in Antananarivo. Antananarivo is the top priority in the urban transport sector, while it is also important to support secondary city development in the long term. Urban residents use different types of transport modes, such, minibus, also called "taxibe", tuktuk and rickshaw bicycle. These transport services are largely "informal" and loosely regulated. Because of limited urban space for road and the informality of the sector, their operations are generally inefficient and unsafe, though perhaps cheap. The people's transport mobility is most constrained in Antananarivo. An average trip in Antananarivo takes 46 minutes one way, twice longer than those in other secondary cities where people commute 15-25 minutes.

Vulnerability of urban transport to shocks. The current COVID-19 pandemic reveals a particular

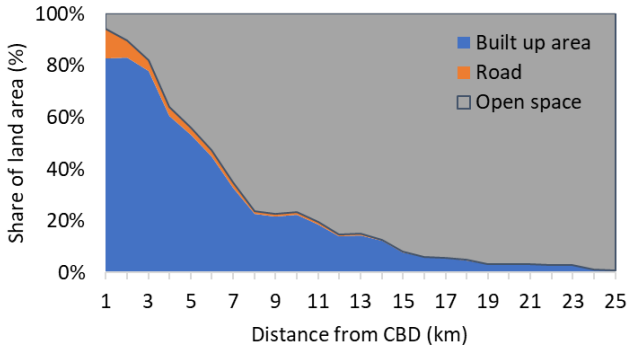
vulnerability of urban transport services in large cities. Especially, the mobility in Antananarivo was constrained substantially when travel restrictions were imposed, and ever after they were lifted. Many bus users lost access to their workplaces. In addition, many transport operators were also faced with a significant financial difficulty with the sharply dropped demand but continued loan payments.

Land Use Patterns

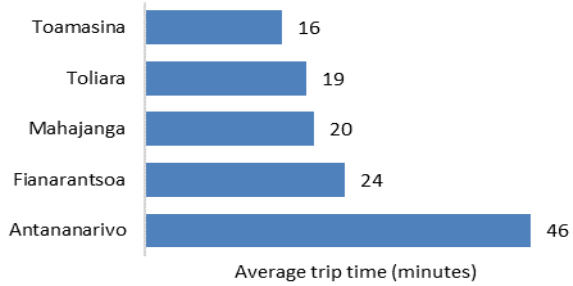
(Paris)



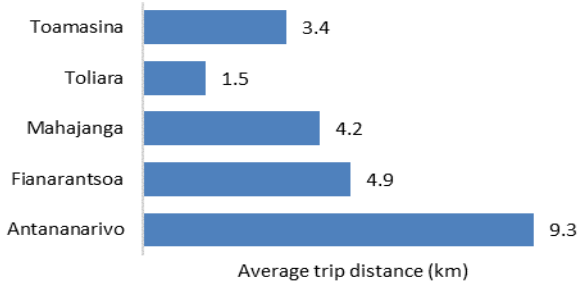
(Antananarivo)



Average Trip Time in Selected Cities



Average Trip Distance in Selected Cities



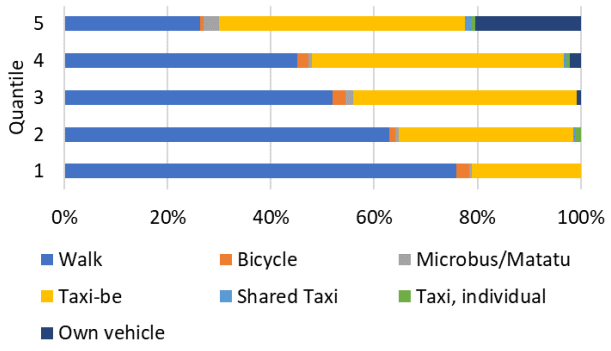
Need for more intensified, efficient public transport services. Given the limited land space for transportation, it is essential to intensify public transport services. In Antananarivo, minibus is the most important means of public transport, however, half of the residents still just walk, not using any public transportation. Although affordability is one issue, it is more important to warrant efficient services to those who live in non-service and remote areas and do not have access to the transport services. In Antananarivo, people spend on average 5.2 percent of their income on transportation, which is higher than the regional average but within the regional norm of 2 to 8 percent. Currently, the minibus sector is estimated to transport about 1.4 million passengers per day, but more people could take advantage of the services if the operations were organized better. The trip time elasticity of demand is estimated to be significant in Antananarivo. The income elasticity is also found to be positive. Thus, as the economy grows, more people, not less, would likely use minibuses. There is no alternative at present. The private car ownership remains minimal in Antananarivo (6 percent).

Mobility, access to jobs and urban poverty. Because of the lack of efficient and reliable transportation, people are currently missing opportunities to be paid better. Antananarivo is the center for growth in Madagascar. Well-paid jobs are concentrated in the center of the city. It is estimated that by commuting, workers could gain on average 20 percent higher salaries (i.e., MGA276,000 or US$78 per month). Despite potential opportunities, people do not have access to jobs. Firms are failing to hire good workers.

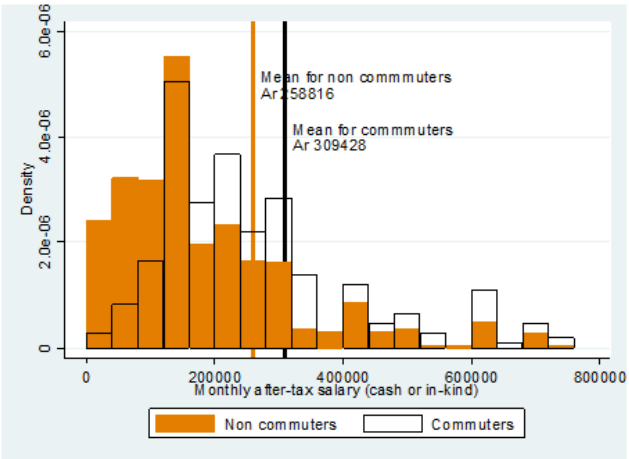
People have to commute on average about 45 minutes on board of crowded minibus. People who live in live in suburban areas where the available public transport services are limited are most affected. About two-thirds of the overall trips are made between CUA and suburban areas. Because of the poor urban planning and lack of efficient transport systems, the city has been overconsuming land and over-sprawling. Thus, land and housing prices in the middle of Antananarivo are extremely high, pushing the poor away to remote suburban areas. Many people are forced to either commute long distances every day or live in unfavorable living conditions within the city.

Climate resilience and mitigation. From the climate change perspective, there are considerable opportunities that Malagasy cities could exploit by building resilient and efficient public transport systems. Madagascar is vulnerable to extreme climate events. Because of poor drainage systems, the transport connectivity in the city is easily disrupted by heavy precipitation. Over 500 km of roads or about 16 percent of the city's total road network are located in flood-prone areas. It is important to build more resilience in transport infrastructure and services. The improved efficiency in the public transport systems also contributes to climate change mitigation. Public transit is generally two to four times more energy-efficient than private vehicle use.

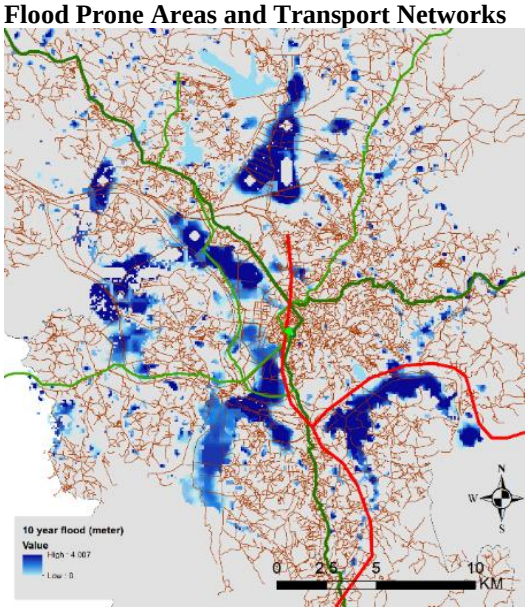
Share of Transport Modes by Income Group



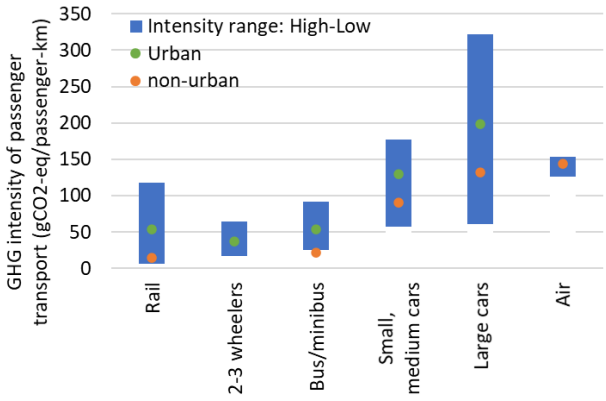
Monthly Wages for Commuters and Noncommuters



Flood Prone Areas and Transport Networks



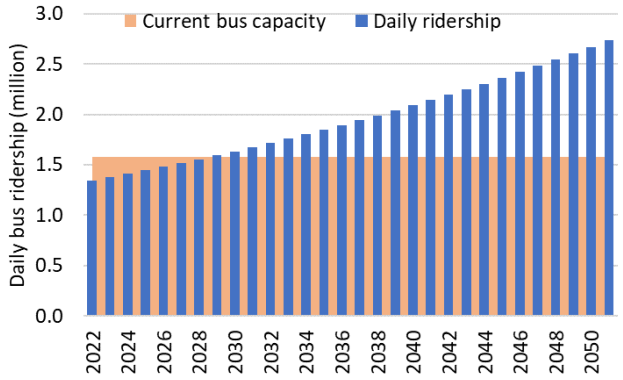
GHG Intensity of Passenger Transport



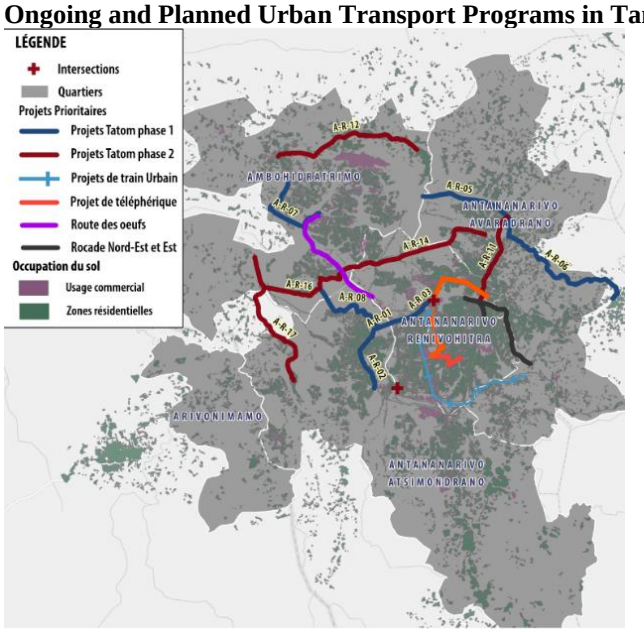
Increasing demand forecast and capacity constraints. The current minibus capacity would likely be exceeded by the people's daily demand by 2029. While the current minibus ridership is about 1.4 million trips per day, the supply capacity of public transport (i.e., minibus) is estimated at 1.6 million per day given the current operating conditions. The demand would be doubled to 2.7 million rides per day by 2051. Regardless of income level, the vast majority of transport users would likely continue to rely on minibuses.

Toward more efficient and greener urban transport systems. Since available urban space for transport infrastructure is limited in Antananarivo, there is no other way than intensifying the use of public mass transit. The private vehicle ownership looks gradually growing as household income increases especially around Antananarivo. However, it is not sustainable to rely on private vehicle use. Now comes a critical moment to pave a path toward greener, sustainable urban transport development.

Current Bus Capacity and Demand Forecast



Ongoing and Planned Urban Transport Programs in Tana



Poorly designed and coordinated ongoing urban transport programs. In recent years, the Government has embarked upon new important urban transport projects in Antananarivo, including ring roads, bypass, cable cars, and urban rail transit. Unfortunately, however, they are often fragmented and poorly coordinated without assuring any clear long-term vision of urban development. Some of them lack rigorous economic, financial, or environmental and social assessments, posing a question on their feasibility and sustainability. A holistic approach is needed to meet the rapidly increasing demand for urban mobility effectively and efficiently.

Need for strong infrastructure governance. At the macroeconomic and fiscal level, the importance of having strong infrastructure governance cannot be overemphasized in developing countries. It is estimated that about 40 percent of the returns on public investment are lost because of inefficiencies in the public investment management. Common areas of concern are project prioritization and project appraisal (IMF 2019). In Madagascar, the institutional framework can be improved further to strengthen

public infrastructure governance through establishing a more rigorous mechanism to prioritize, select and appraise public investments.

Plans exist but are not often implemented. At the sectoral level, it is important to not only prepare but also implement a long-term urban development strategy consistently. In Madagascar, there are well-prepared urban development and transport studies. However, their implementation is often delayed or not realized at all. Following a comprehensive urban development study for Antananarivo (TaToM), the urban transport master plan (Etude du Schema Directeur du Transport dans la Ville d'Antananarivo) has just been prepared in December 2021. It proposes a phased approach to (i) develop ring roads and priority urban roads connecting suburban areas to the center of the city, (ii) rehabilitate and extend urban rail lines, and (iii) introduce cable car lines. Over the medium to long run, it also envisages to introduce bus rapid transit (BRT) and other mobility services. The plan remains to be implemented with all relevant projects aligned.

More integrated approach focused on people's mobility. The proposed urban transport master plan for Antananarivo is heavily concentrated on physical infrastructure investments, such as wider roads, bypasses, and intersection improvements, which are necessary but not sufficient to support sustainable mobility in the urban sector. To fully benefit from urbanization and agglomerations, international experience shows that managing motorization by encouraging the use of greener modes of transport, such as public transport, bus, train, biking and walking, is fundamental. For Antananarivo, such an integrated transport mobility plan remains to be developed with complete streets, multimodal streets, and integrated corridor management approaches used.

Creating champions for reforms. To promote the vigorous implementation of long-term development plans, it is important to create champions for necessary institutional reforms. In Antananarivo, there are two regulatory systems to govern urban transport at the national and subnational levels. While the national transport agency (ATT) is a regulatory authority for suburban transport, the Urban Commune of Antananarivo (CUA) is responsible for within-city transport services. Currently, there is no effective coordination mechanism to match supply and demand. A more integrated organizational structure or coordination mechanism is needed to support all modes of urban transport across different jurisdictions from a holistic point of view.

Need for rigorous project economic analysis. At the project level, it is critical to carry out project economic analysis in a rigorous manner. Economic analysis compares a project's economic benefits and costs and can provide a guidance on how to prioritize public investments and which interventions should be prioritized. Common indicators that are used include: economic internal rate of return (EIRR), net present value (NPV), benefit-cost ratio and cost-effectiveness (e.g., costs per beneficiary). The Urban Train Project and the Cable Car Project have already been started and are expected to contribute to improving connectivity in specific areas within CUA. Based on the estimated OD matrix, they could benefit only 11 percent and 6 percent of the total demand for mobility, respectively. The synergy with other priority urban transport interventions remains be explored.

Comparing the options. Given the current traffic patterns, one of the most important mobility constraints is caused by traffic congestion at specific points during peak hours. These congestion points are concentrated along the major national roads and around the borders between CUA and suburban districts. Thus, priority should be put on improving the interface between the two bus networks, while diverting unnecessary traffic to the outside of the city.

Applying the conventional cost-benefit analysis method, four public transport interventions that are particularly focused on public transport are compared.

- **Bus route optimization program.** The current bus routes are duplicated with no hierarchy. Some routes are excessively long and operationally inefficient. The two city and suburban bus networks are overlapped, creating extra congestion. By developing the interface between the two networks and improving extremely congested intersections, the efficiency in minibus operations could be significantly improved.

- **Bus fleet renewal program.** The current average fleet age is already 23 years. By introducing larger and more efficient bus fleet along major corridors, the public transport capacity could be increased with an adequate operational hierarchy established. The program could also contribute to safety improvement as well as climate change mitigation.
- **Innovative ticketing systems.** The fleet renewal program can integrate an innovative ticketing system, which allows operators to improve their operational efficiency and introduce demand-side management through differentiated fare systems. Users can also benefit from other integrated mobile services.
- **Passenger rail.** The Government has already embarked upon the Urban Train Project between Ankorondrano and the Gare de l'Est, passing through the Gare de Soarano, over a total length of 15.5 km. While the institutional arrangements remain unclear on both implementation and operation sides, the project is expected to contribute to reducing road traffic from and to the south of the city.
- **Urban road development and traffic management.** This is not compared with the above-mentioned interventions. The TaToM study identifies 17 priority urban road projects in Greater Antananarivo. The total costs are estimated at US$230 million for the first phase and US$337 million for the second phase, respectively. Although further economic feasibility analysis is still needed, the current and expected level of traffic along these main corridors is about 1,500 to 3,000 vehicles per day, which could generally justify economic feasibility of these projects. However, the prioritization is essential, as suggested by the master plan.

The results. Among the four interventions related to public bus and rail transport, the bus fleet renewal program with bus route optimization combined is considered to be economically most viable with the highest rate of return. The bus route optimization with some intersection improvements can also achieve a relatively high rate of economic return, indicating a lot of potential to ameliorate operational efficiency through institutional reforms in the bus sector. The urban transit projects are economically viable. The modified Urban Train Project is considered to be marginally economically viable. It is critical to contain the project costs, while pursuing wider economic benefits under a solid development plan. A further detailed feasibility study seems to be needed.

Summary of Cost Benefit Analysis of Different Urban Transport Interventions

Intervention	(1) Bus route optimization	(2) Fleet renewal	(3) Ticketing systems	(4) Passenger rail
Investment cost ($ mil)	20.9	241.7	27.8	45.0
Operating cost ($ mil)	4.2	3.9	15.2	105.9
Daily ridership (million)				
2021	1.34	1.34	1.34	1.34
2031	1.70	1.86	1.68	1.68
2041	2.18	2.37	2.14	2.15
2051	2.78	3.03	2.74	2.74
Economic Internal Rate of Return (%)	27%	38%	...	6%
Net Present Value ($ mil)	44.4	101.7	-25.7	0.014

Recommendations. To address short- and long-term challenges in the urban transport sector in Greater Antananarivo, a holistic approach is required at different levels. The Government of Madagascar has already embarked upon several important urban transport projects. To maximize their economic benefits and ensure their sustainability, not only infrastructure investments but also institutional reforms are needed.

To meet the rapidly increasing demand for urban mobility effectively and efficiently, a holistic approach is needed at different levels: macro, sectoral, and individual.

At the macroeconomic and fiscal level, it is of vital importance to strengthen infrastructure governance and be equipped with a solid, evidence-based, systematic mechanism to prioritize, select and implement public investments. It is important to build a systematic mechanism to process and evaluate unsolicited proposals.

At the sectoral level, it is a priority to fully implement a long-term urban development strategy consistently. It is of importance to agree on a long-term vision of urban transport development, which is elaborated by the recently proposed urban transport master plan (SDT). The plan remains to be implemented with all relevant projects aligned. In Madagascar, there is often a significant gap in implementation of development strategies. Well-prepared overall studies are often ignored. It is critical to ensure the SDT is actually implemented.

It is recommended to prepare a complementary urban mobility study more focused on people's mobility, using integrated approaches (e.g., Complete Streets, Integrated Corridor Management). The proposed urban transport master plan for Antananarivo is heavily concentrated on physical infrastructure investments, including roads, railway and cable cars, which are necessary but not sufficient to support sustainable mobility in the urban sector. A more integrated approach focused on people's mobility is worth considering.

To assure the full implementation of the development plan, it is of particular use to create champions for necessary institutional reforms. There are different ministries, agencies and municipalities, including ATT and CUA, that are responsible for urban transport development in Madagascar. It is essential to develop a well-functioning coordination mechanism or unit with clear mandates and responsibilities for planning, regulating, managing and financing urban transport development.

While creating new authorities may be seen as a long-term goal, it is useful in the short term to work within existing agencies, for example, CUA and/or ATT, to develop the necessary capacity. The activities of the new urban transport authority should be financed by sustainable financial resources. Potential revenues in the sector, such as vehicle registration fees and license fees, can be pooled and used for its operations, but they may not be sufficient. The operating costs must be financed by more sustainable sources, such as national budget.

At the individual project level, it is essential to ensure that all large public infrastructure investments are evaluated by rigorous project economic analysis. Project economic analysis allows to compare different potential options in a systematic manner and provide a guidance on how to prioritize public investments. The Government has recently embarked upon important mass transit projects, such as cable car and Urban Train Projects, in Antananarivo. To ensure their technical, economic viability and sustainability, rigorous economic, environmental and social feasibility studies remain to be conducted.

Bus sector restructuring, including licensing and fare reforms, is an important complementary policy intervention to improve urban mobility in Antananarivo. Bus is the most important means of transport in GA. It is inevitable to intensify the use of public mass transit systems because the land areas dedicated to urban transport infrastructure are extremely limited in Antananarivo.

Bus sector interventions focused on regulations and institutional aspects are largely economically viable. Particularly, the bus fleet renewal program combined with bus route restructuring and development of an efficient interface between within-city taxibe and suburban buses is estimated to be highly economically

viable because of both time savings for passengers and reduced operating costs (per passenger) for operators.

The modified Urban Train Project is marginally economically viable. The rate of return is relatively low. It is critical to contain the project costs, while pursuing wider economic benefits, such as transit-oriented development and land value capture.

While the proposed reform agenda is ambitious, unmet financial need is also huge. Given the available information in the proposed urban transport master plan, the overall financial need for urban transport infrastructure development is estimated at US$1.7 billion for the next two decades, which includes the proposed interventions in the bus sector. The relatively short-term need is approximately estimated at US$550 million. Over the medium term, about US$680 million would be needed. At least another US$470 million would be needed over the long term.

The urban transport program needs to be implemented in a phased manner. For sustainability purposes, it is essential to establish strong infrastructure governance in the urban transport sector and develop a national urban transport funding mechanism in the long run. Some of the policy reforms take more than others. The gradual capacity building is essential with political support ensured.

Summary of Priority Institutional and Infrastructure Interventions in Urban Transport Sector

Macro / Fiscal Level	
• Strengthen infrastructure governance • Evidence-based mechanism to prioritize, select and implement public investments	• Establish a systematic system to evaluate unsolicited proposals
Sectoral Level	
• Implement the urban transport master plan (SDT) • Prepare a complementary urban mobility study more focused on people's mobility, using integrated approaches (e.g., Complete Streets, Integrated Corridor Management)	• Establish an effective coordination mechanism/unit between CUA and ATT • Consolidate the legal texts and clarify roles and responsibilities among different entities Strengthen its regulatory capacity for urban transport • Establish an urban transport financing mechanism
Individual Project Level	
• Carry out rigorous project economic analysis, including operation and maintenance arrangements • Carry out environmental and social impact assessments	• Explore complementarities among projects under the overarching urban transport master plan

Bus sector restructuring

- Comprehensive transit system redesign study
- Revise the licensing scheme
- Enforce operational regulations

- Develop terminals between city and suburban buses
- Improvement of inersections

Bus fleet renewal

- Detailed economic and makret analysis
- Develop a fleet reneual program
- Profesionalize operators

- Investment in fleet
- Improvement of bus stations
- Introduce ticketing systems

Passenger rail

- Detailed feasibility study
- Technical assessment of infrastructure (e.g. electrical)
- PPP study
- Regulatory framework for operations

- Rehabilitation of infrastructure
- Rolling stock
- Development of intermodal facilities

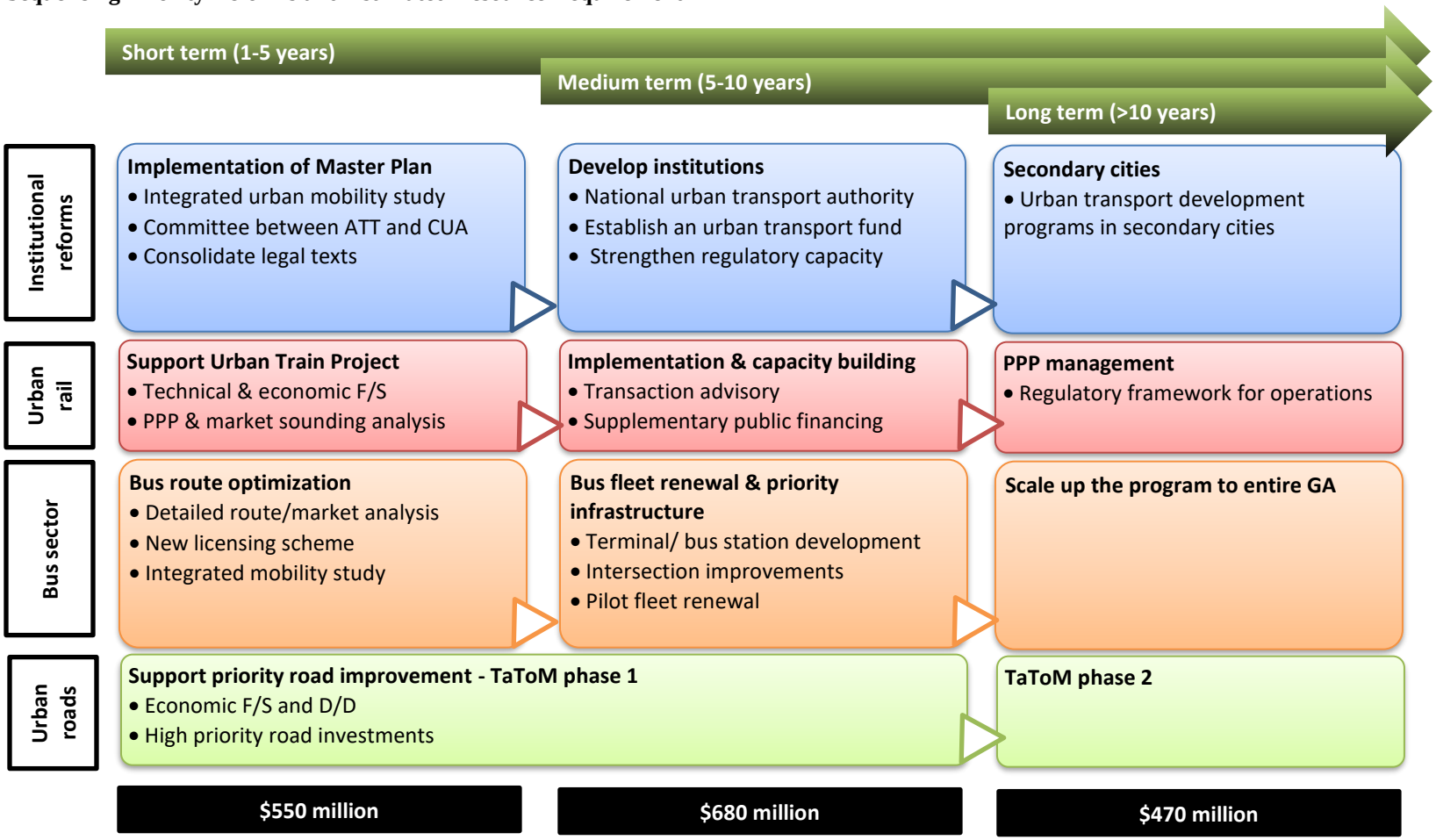
Urban road development

- Feasilibity study and further prioritization
- Integrated mobility study
- Urban road financing plan
- Road maintenance & resilience study

- Improvement of intersections
- Investment in priority roads
- Integrated infrastructure for NMT

Investment

Sequencing Priority Reforms and Estimated Resource Requirement

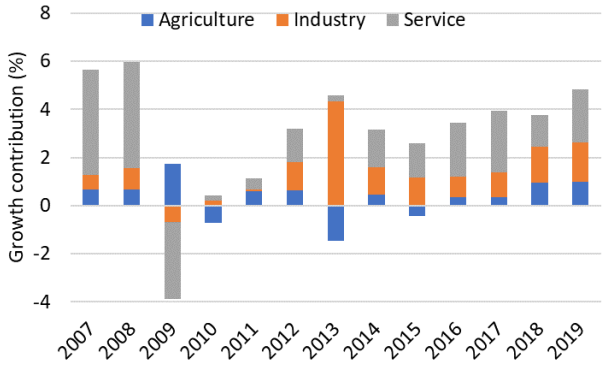


I. Introduction

Madagascar remains to exploit agglomeration economies and urbanization economies to sustain more rigorous economic growth. After several political and economic turbulences, Madagascar restored its modest but steady growth path with an average growth rate of 3.5 percent in the last 5 years (before the COVID-19 pandemic) (**figure 1**). The country is the fourth largest island in the world, with a total population of 25.7 million,[1] and has a wide variety of economic potentials, such as tourism, agrobusiness, fishery, light manufacturing and mining. In recent years, the service sector has particularly been growing with accelerated urbanization, while agriculture remains an important economic sector, employing 75 percent of total labor force, generating 25 percent of GDP and earning 30 percent of foreign exchange for the country.

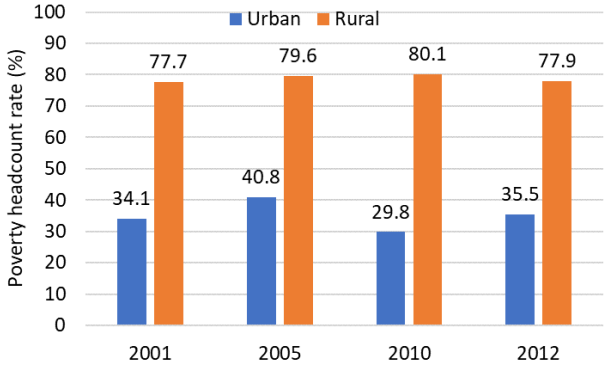
Yet, the country's growth performance remains less favorably compared with other countries in the region. Poverty is also persistently high in Madagascar, with a large spatial disparity in poverty incidence across areas. The country's GDP per capita is among the lowest in the world, USD523. About 21 million Malagasy people or 76.5 percent of the total population is estimated to live under the poverty line.[2] According to the international poverty line of USD1.90 (2011 purchasing power parity) per day, the poverty rate seems to have fallen only slightly from 78.8 percent in 2012 to 76.5 percent in 2019. It remains much higher than the regional average of 41 percent. Rural poverty has been a change to Madagascar for a long time. The latest available national poverty statistics indicates that the vast majority of rural residents – about 80 percent – are poor (**figure 2**).

Figure 1. Madagascar: GDP Growth Rate by Sector



Source: World Development Indicators.

Figure 2. Poverty Headcount Rate in Madagascar



Source: World Bank (2016a).

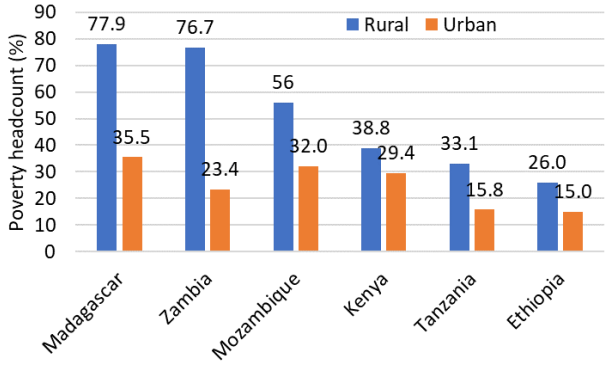
Urban poverty is relatively modest but is also an important challenge for Madagascar. Although fluctuating over time, Madagascar has one of the highest urban poverty rates in the region (**figure 3**). The urban poor is particularly vulnerable to external shocks, such as COVID19. In Madagascar, it has been affected by various events. In 2005, the urban poverty rate increased because of a sharp drop in urban employment caused by the 2002 political crisis (**figure 4**). During the second half of the 2010s, many people went back to the agriculture sector because of marked market prices of agricultural commodities, such as rice, in unfavorable weather conditions (World Bank 2016a). As the urban sector is recovering, urban poverty is likely to exhibit an increasing trend once again. The COVID pandemic is likely to reverse more than a decade of gains in poverty reduction in Madagascar.

Madagascar has been experiencing accelerated urbanization in recent years. The urban population in Africa was

[1] According to INSTAT (2018) RGPH-3.
[2] According to *World Development Indicators*.

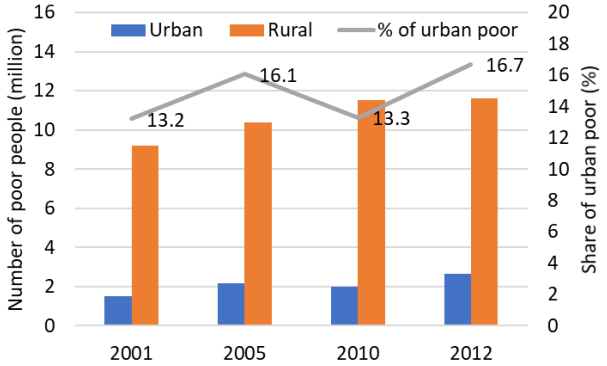
more than doubled from 200 million in 1990 to 548mbillion in 2018 (UN ESA 2018). In Madagascar, the urban population increased by four-fold from 2.7 million in 1990 to 10.7 million in 2020.[3] About 40 percent of the total population live in urban areas (**figure 5**). The average urban population growth rate is among the highest in the region. It was 4.7 percent during the last 15 years (**figure 6**). The country's urban population is projected to continue growing rapidly, exceeding rural population by 2040 (**figure 7**).

Figure 3. Rural and Urban Poverty Rates



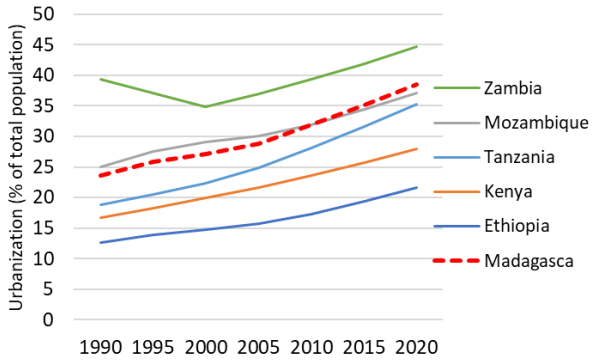
Source: Various poverty assessment studies.

Figure 4. Number of Poor People in Madagascar



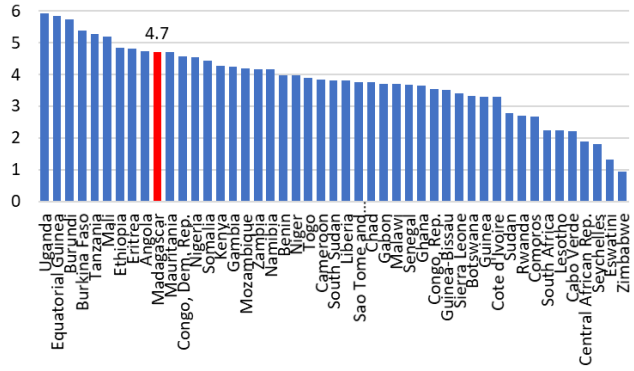
Source: World Bank (2016a).

Figure 5. Urbanization Rates in Selected Countries



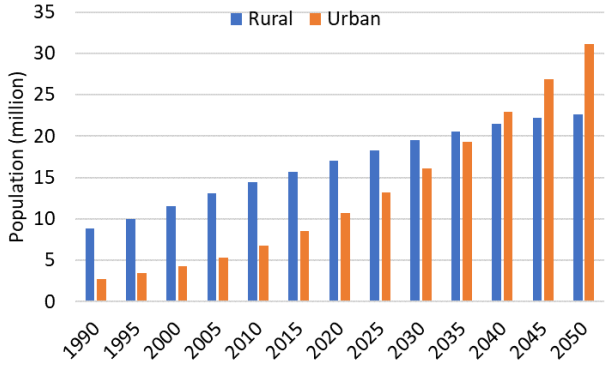
Source: World Development Indicators.

Figure 6. Urban Population Growth in Africa



Source: World Development Indicators.

Figure 7. Madagascar: Urban and Rural Population



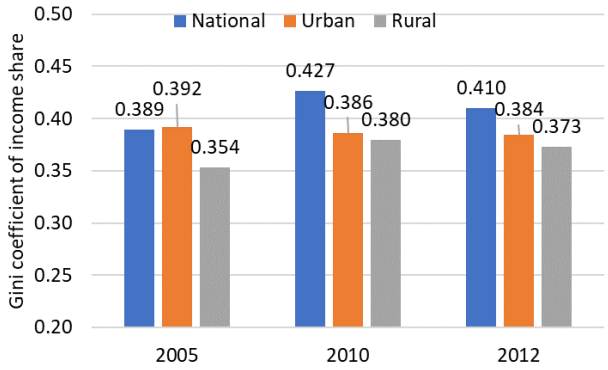
Source: UN ESA. (2019).

[3] According to *World Development Indicators*. Based on the national census, the urban population increased from 2.8 million in 1993 to 4.9 million in 2018.

For long-term inclusive growth, it is essential to support the livelihoods of urban residents. Among others, urbanization is one of the most important driving forces for economic growth, however, the urban sector does not always have the capacity to absorb the growing population. Globally, there is strong correlation between national income and the level of urbanization, but an association between urbanization and economic growth is less apparent (UN ESA 2018). To maintain cities' competitiveness, it is important to assure equitable access to job opportunities for everyone and enhance their mobility in urban areas.

In urban Madagascar, opportunities are not equally distributed. By region, Sub-Saharan Africa has the second highest inequality after Latin America. In some cities, such as Johannesburg, Cape Town, Kigali and Blantyre, the Gini coefficients exceed 0.4 (UN Habitat 2020a). In Madagascar, urban areas also displayed a high inequality of 0.38-0.39 (**figure 8**). According to the latest household survey in Antananarivo in 2016, the Gini coefficient of household income is estimated to be even higher at 0.452 (World Bank 2016b).

Figure 8. Gini Coefficients in Madagascar



Source: World Bank (2016a).

Access to well-paid employment is hampered by unreliable and inefficient transport services in urban Madagascar. Job opportunities may exist, especially in Greater Antananarivo where about 60 percent of formal enterprises are located (**figure 9**).[4] However, access to such opportunities is not always be warranted because the available public transport services are unreliable and inefficient (World Bank 2016a). Average operational speed of taxibe (minibus) is 10 to 20 km per hour. Average fleet age is more than 20 years (World Bank 2019). Half of the residents in Greater Antananarivo walk to work, not using any public transportation. Poor households are forced to live in remote areas or under unfavorable living conditions, such as flood-prone areas. Avoiding such risks requires on average 11 percent more rent (World Bank 2017). In Madagascar, about 61 percent of the urban population live in slums, which is one of the highest in the region (**figure 10**).

Well-planned urban development and urban transport management are essential to support the people's access to socioeconomic opportunities, while stimulating agglomeration economies. Without good planning, cities tend to overconsume land faster than they grow in population, resulting in inefficient urban sprawl, traffic congestion and long commuting time (UN ESA 2020). Madagascar, especially, Antananarivo, is on the verge of it. According to the Global Least & Most Stressful Cities Ranking, Antananarivo is ranked 109th of 150 major cities in the world.[5] While Baghdad is the most stressful city, Stuttgart in Germany is the least stressful city (**figure 11**). Regarding

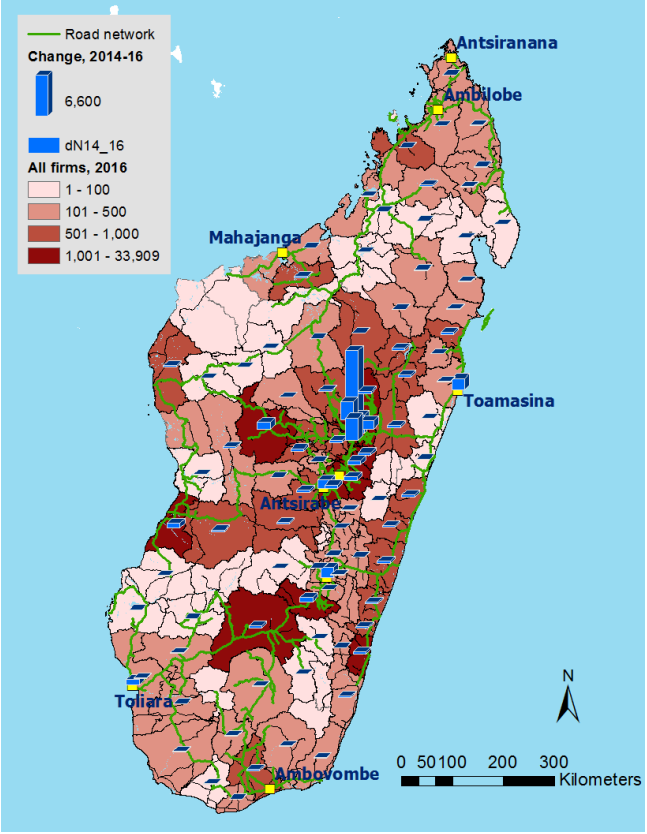
[4] In Madagascar, there were about 120,000 enterprises registered in 2016.

[5] To assess stressfulness of cities, the Global Least & Most Stressful Cities Ranking analyzes a wide variety of measurements representing city's congestion, pollution, finance and people's health conditions.

traffic congestion, Antananarivo is ranked worse at 134th.[6] This is worse than Nairobi (129th) (**figure 12**). For public transport measured by users' satisfaction, the score of Antananarivo is also among the lowest.

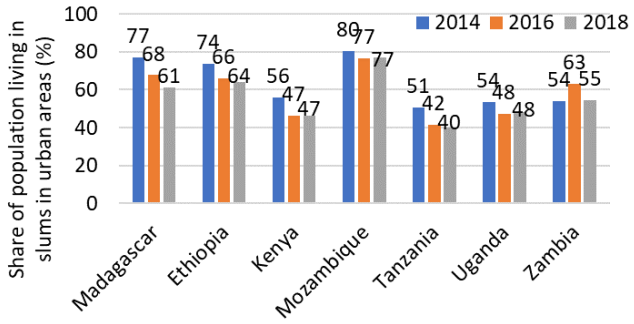
The economic costs of inaction are significant. In Antananarivo alone, it is estimated that the economy loses about US$40 million or 0.34 percent of GDP every year, because of traffic congestion. In relative terms, this is almost comparable to the economic losses that the United States lost because of traffic congestion in 2018 (i.e., US$87 billion or 0.4 percent of GDP). In Antananarivo, minibus users spend 46 minutes on board of the vehicle. Since the average operating speed of minibus during the peak hours is 21.8 km, much slower than an average free flow speed of 33.3 km per hour, people are considered to lose on average 9 minutes because of traffic congestion. This has a huge implication on the economy as a whole. In Greater Antananarivo, the public transport systems (i.e., minibus) carry about 1.6 million passengers every day. Before it becomes too late, it is imperative to address key urban transport challenges to assure people's efficient and safe accessibility and ensure sustainable urban growth in Madagascar.

Figure 9. Firm Location by District



Source: World Bank (2018).

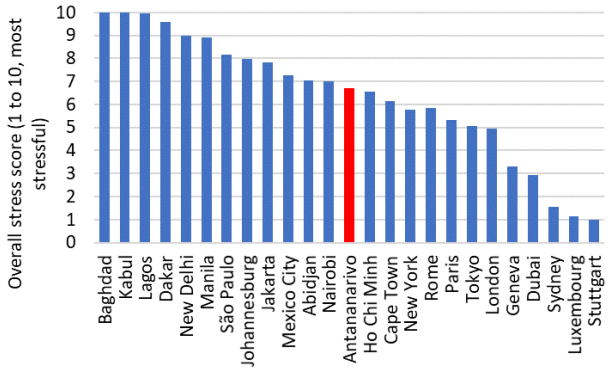
Figure 10. Urban Population Living in Slums



Source: World Development Indicators.

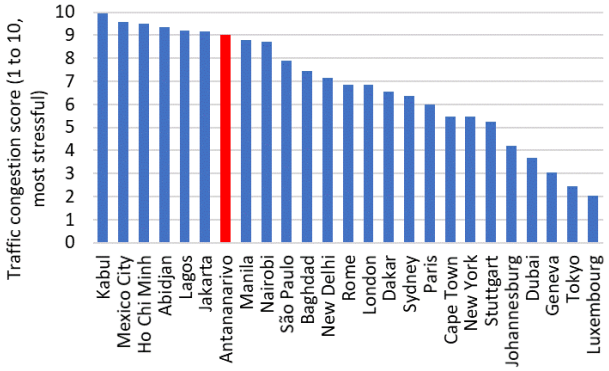
[6] Traffic congestion is assessed based on the TomTom Traffic Index and the Inrix Global Traffic Scorecard.

Figure 11. Most Stressful Cities in Selected Countries



Source: ZIPJET (2017).

Figure 12. Traffic Congestion Scores in Selected Cities



Source: ZIPJET (2017).

The objectives of the report. Given the above background, the current report aims at (i) reviewing the trends of urbanization and urban transport developments in major cities in Madagascar, (ii) analyzing the current and future demand for urban mobility with focus on Greater Antananarivo, (iii) providing an overview on the current government urban transport programs and exploring complementary interventions to maximize the synergy among the programs, and (iv) summarizing policy recommendations to ensure sustainable urban growth in Madagascar.

The report builds upon various recent studies, particularly the following four analyses:

- World Bank (2019). Spatial Analysis of Antananarivo: Transport Access, Poverty and Jobs;
- CPCS (2021a). Pre-feasibility Study: Improving Urban Transport in Greater Antananarivo: Review of bus operations and passenger rail operations;
- CPCS (2021b). New Smart and Safe Mobility in Antananarivo and Other Cities; and
- Iimi (2021). Background paper: Estimating the Demand for Informal Public Transport: Evidence from Antananarivo, Madagascar.

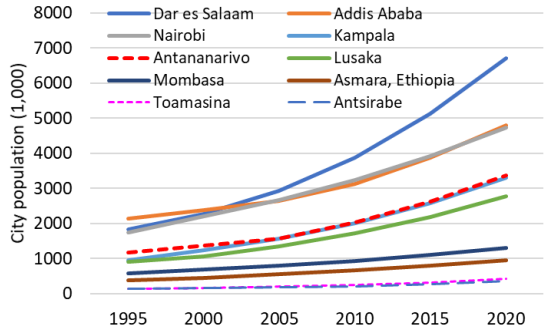
II. Overview of Urban Transport in Madagascar

Urbanization and National Traffic Trends in Madagascar

Madagascar has been experiencing rapid urbanization in recent years. Particularly, Antananarivo, the primary city in the country, continues growing vigorously. With a total population of 3.3 million, it is currently the fourth largest city in the Eastern and Southern African region, following Dar es Salaam, Addis Ababa and Nairobi (**figure 13**). According to the national census, half of the country's urban population lives in Greater Antananarivo (**figure 14**).[7]

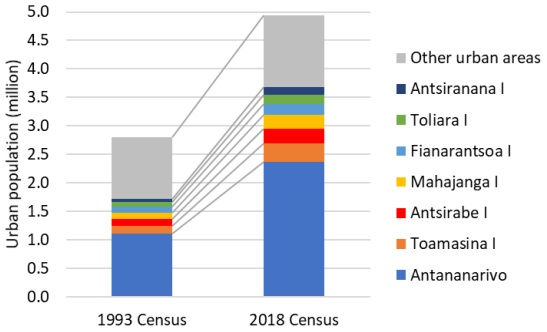
Other secondary cities, such as Toamasina and Mahajanga, also grow, however, Antananarivo is predominant. The city populations are much small at 0.3 million for Toamasina and 0.2 million for Mahajanga, less than one-tenth of Antananarivo. In particular, its suburban areas (Antananarivo Atsimondrano and Antananarivo Avaradrano) are growing even faster (**figure 15**). Unlike other African countries, the primary city ratio in Madagascar has been increasing, from 39 percent in 1993 to 48 percent in 2018. This is not a common phenomenon in the region, except for Zambia (**figure 16**).[8] In general, as an economy grows, secondary cities become more important and grow faster. In the world, secondary cities with less than 1 million inhabitants account for 59 percent of the global urban population (UN Habitat 2020a). In the case of Madagascar, however, Antananarivo is already most congested but still continues growing vigorously.

Figure 13. Populations Major Cities in the Region



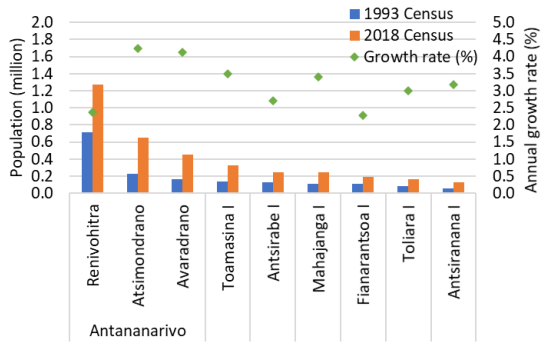
Source: UN Habitat (2018).

Figure 14. Urban Population by City



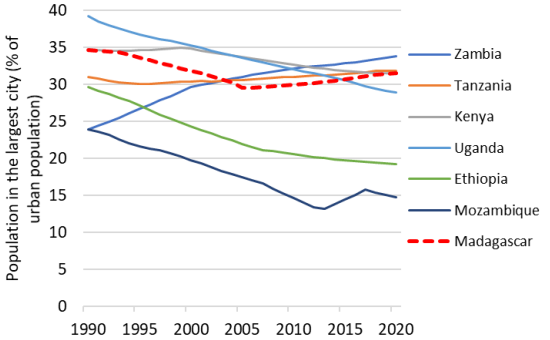
Source: INSTAT (2018).

Figure 15. Urban Population Growth Rates



Source: INSTAT (2018).

Figure 16. Share of Population of the Largest City



Source: World Development Indicators.

[7] Including three districts: Antananarivo Renivohitra, Antananarivo Atsimondrano, and Antananarivo Avaradrano.

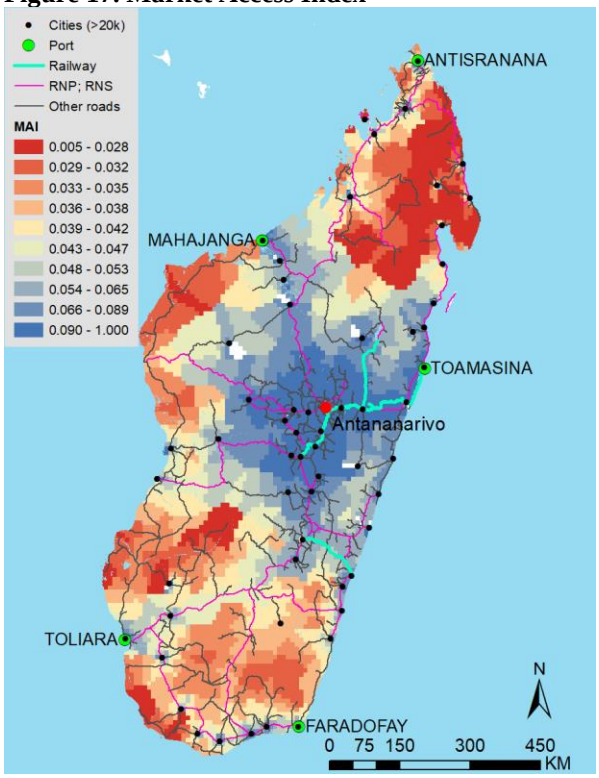
[8] The significant increase of the primary city concentration in Zambia is attributed to not only natural urban population growth but also increased rural-urban migration driven by strong growth in urban employment, particularly in Lusaka (Crankshaw and Borel-Saladin, 2018).

The high primary city concentration implies that Antananarivo is an important market for everyone, including secondary cities. The Market Access Index (MAI), which is a general measurement of domestic market accessibility with transport connectivity and population distribution taken into account, is clearly supportive of this: The MAI is particularly high around Antananarivo (**figure 17**).

The connectivity to Antananarivo is vital for secondary cities as well. Madagascar has a road network of about 32,000 km. The major national roads already connect most of large cities. The MAI is estimated to be high along those national roads, meaning that they play an important role to connect Antananarivo to the rest of the country. The country owns other transport modes, such as railway and maritime transport (cabotage), but they have not been fully integrated. Some are in need of repair, and others are currently underutilized.[9]

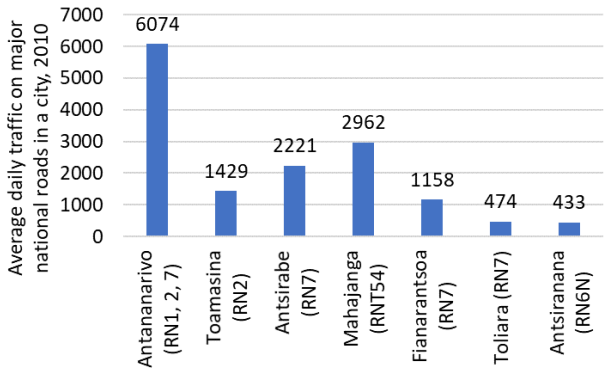
Antananarivo tends to be overcrowded with too much traffic attracted nationwide. The country's freight traffic tends to be concentrated though major national roads, which all converge on Antananarivo. Road transport carries about 90 percent of the total freight traffic in Madagascar. The average traffic on the national roads around Antananarivo is over 6,000 vehicle per day, which are two to ten times more than those in secondary cities (**figure 18**). Thus, not only within-city traffic but also traffic flows from the outside need to be managed to assure efficient movements of goods and people in the city.

Figure 17. Market Access Index



Source: World Bank (2018).

Figure 18. Average Daily Traffic on National Roads

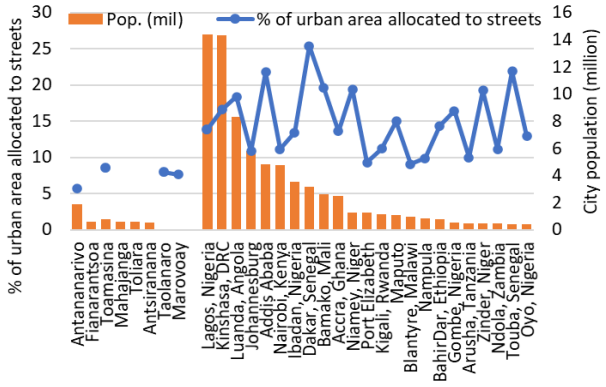


[9] About 670 km of rail lines out of 845 km are currently operational under the concession contract with Madarail, mainly connecting Antananarivo and Toamasina. The operational efficiency and reliability remain low. The primary port, Toamasina, handles 80 percent of the country's total cargo. Other ports have extra capacity but are currently underutilized.

Endowment of Urban Transport Infrastructure

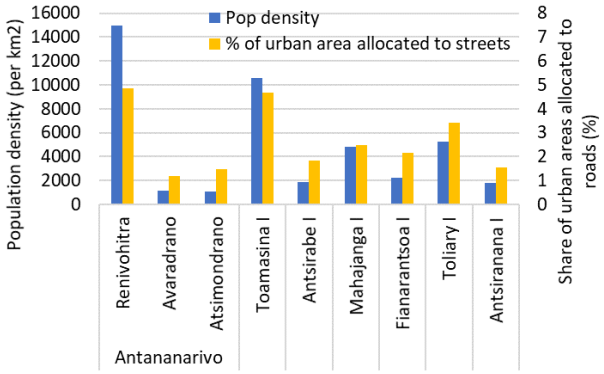
Because of the lack of well-prepared land use and urban development plans, Malagasy cities lack space dedicated to transport infrastructure. Globally, well-developed cities allocate about 15 to 25 percent of land for urban roads (Lall et al. 2017). This is an important norm to ensure sustainable development of cities and assure people's efficient mobility and present urban lives. Even among African countries, which tend to lack space for urban transport infrastructure, large cities, such as Lagos, Kinshasa and Addis Ababa, are estimated to use more than 10 percent of land for streets (**figure 19**). In Madagascar, too little land is dedicated to urban transport infrastructure, such as roads. Antananarivo and Toamasina are estimated to use only about 5 percent of urban areas for roads. With population density taken into account, Antananarivo is considered to be 40 percent more congested than Toamasina. Other secondary cities dedicate even less land (i.e., 1-3 percent), but they are also far less populated (**figure 20**).[10] This is partly because of the topographic conditions (e.g., a hilly background around Antananarivo) but mostly because of the weak implementation of urban land management. For instance, the law was updated in 2015 and require for the right of way ranging between 5 to 15 meters, depending on road class. However, the enforcement is still a challenge.

Figure 19. Land Allocated to Roads in Selected Countries



Source: UN Habitat (2018, 2020a).

Figure 20. Share of Land Allocated to Roads by City



Source: World Bank estimates.

Land consumption in Antananarivo and Toamasina is significant, which would require more and more urban transport infrastructure. Their land consumption growth rates exceeded 8 percent per annum, much greater than an annual population growth rate of 2-3½ percent (**figure 21**) The overconsumption of urban land means that the cities are sprawling. In Antananarivo, it is clear that transport infrastructure is particularly insufficient in not only the center of the city but also suburban areas. The land dedicated to transport becomes more and more limited as one moves away from the city center (**figure 22**). Global megacities, such as Paris, and even developing cities, such as Addis Ababa and Nairobi, dedicate more land for roads.

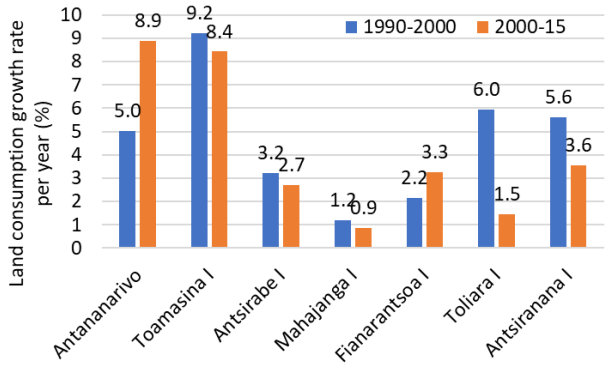
The deficiency of urban transport infrastructure is primarily attributed to the lack of strategic urban planning from a long-term perspective. In Antananarivo, for instance, an urban development master plan was developed in 2004 (Ministry of Transport, Madagascar, 2004), however, it was never implemented. The city has been overconsuming land and over-sprawling.

For other secondary cities, there is no urban development plan or strategy, either. Their current levels of

[10] The areas used by streets are estimated based on the OpenStreetMap, which has better coverage of urban roads than the government data of the classified road network.

urbanization are still relatively modest, but without good urban planning, adequate land use or timely urban transport infrastructure development, they could become rapidly congested, as experienced in Antananarivo. It would become more and more difficult to address urban congestion later on.

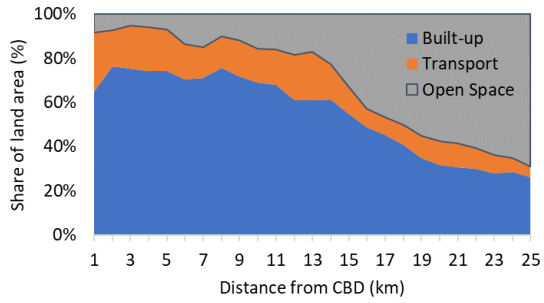
Figure 21. Land Consumption Growth by City



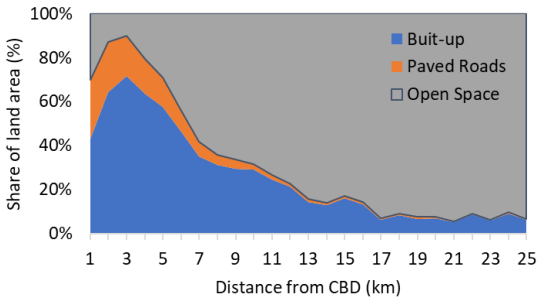
Source: UN-Habitat (2020b) Global Urban Indicators Database.

Figure 22. Land Use Patterns in Selected Cities

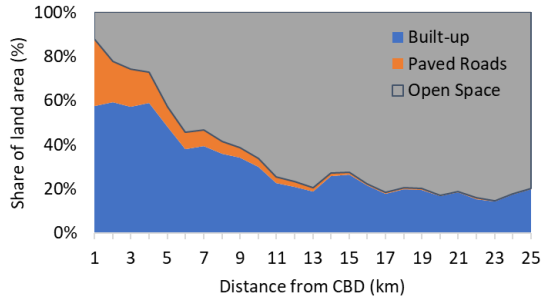
(Paris)



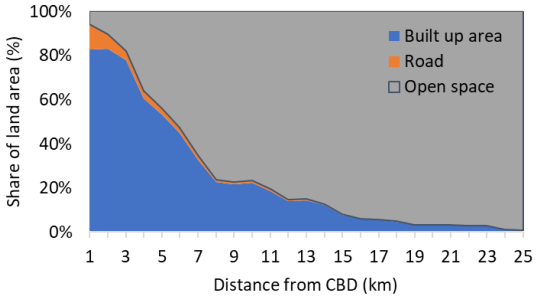
(Addis Ababa)



(Nairobi)



(Antananarivo)



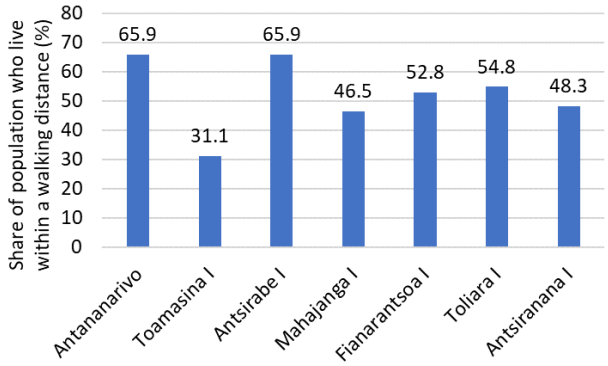
Sources: Lall et al. (2017); World Bank (2019).

People's Mobility in Antananarivo and Other Cities[11]

Because of the limited space available for urban transport infrastructure, the transport services in Malagasy cities must of necessity be more efficient and intensified, rather than sprawling. As in other cities in the developing world (World Bank 2021), Malagasy cities already have many elements of low-carbon passenger mobility. In Madagascar, many urban people have access to public transportation. It is estimated that about half of the city dwellers have good access to some low capacity public transport systems (e.g., bus, tram, etc.) (**figure 23**). However, the current services are poorly organized and largely inefficient.

Available urban transport services are mostly "informal" and loosely regulated. There are different types of transport modes available in urban areas. In Antananarivo, for instance, minibus, also called "taxibe," is a main means of transport for the city dwellers (**figure 24**). Over 6,000 minibuses are on the road in Greater Antananarivo. Taxi and motorcycle taxi are also available. In Toamasina and Mahajanga, tuk tuk, a motorized three-wheeled taxi, is popular. In Toliara, rickshaw bicycle is also used. These transport services are largely "informal" and barely regulated. They are generally relatively cheap but often unsafe and inefficient.

Figure 23. Access to Public Transport in Madagascar



Source: UN-Habitat (2020b).

Figure 24. "Informal" Public Transport Modes in Madagascar

(Taxibe)

(Tuk tuk)

(Cycle taxi on foot)

Informal public transport can be an important solution to support people's mobility under a well-integrated urban transport system. Formal and informal transport modes can coexist. In general, they serve different public transport markets in a city. But it is important to develop a proper regulatory framework to ensure operational safety and efficiency (e.g., Permana et al. 2018; Kumar et al., 2021). In Madagascar, regulatory bodies exist, such as the Land Transport Authority (ATT) and Antananarivo Urban Commune (CUA). In reality, however, few safety and operational regulations are effectively imposed. The markets are self-regulated by private operators

[11] For a more detailed discussion, see CPCS (2021b).

themselves, for example, through their cooperatives. Since there is no official mechanism to match supply and demand, the informal transport services are often overconcentrated only where the demand is high, increasing, not reducing, traffic congestion in urban areas.

It is important to address the current mobility constraint in Antananarivo in the relatively short term, while supporting secondary city development over the long term. Recent data show that the people's transport mobility is most constrained in Antananarivo. CPCS (2021b) shows that an average trip in Antananarivo takes 46 minutes, twice longer than those in other large cities where people travel only for 15 to 25 minutes (**figure 25**). In addition, people living in Antananarivo travel longer distances (**figure 26**). Although it is based on a small sample survey, the people's subjective congestion assessment (i.e., 1: No congestion to 5: Lots of congestion) is on average 4.1 in Antananarivo, followed by Toamasina (3.4). The level of congestion in Antananarivo is twice higher than those in other secondary cities (**figure 27**). The inefficient mobility in Antananarivo is considered to be attributed to its limited urban transport infrastructure as well as high population density (**figure 28**). Toamasina is also congested, but the transport infrastructure endowment is relatively large. The low mobility in Antananarivo is of more concern.

Figure 25. Average Trip Time in Selected Cities

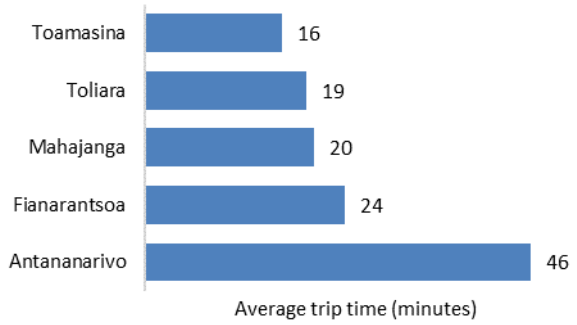


Figure 26. Average Trip Distance in Selected Cities

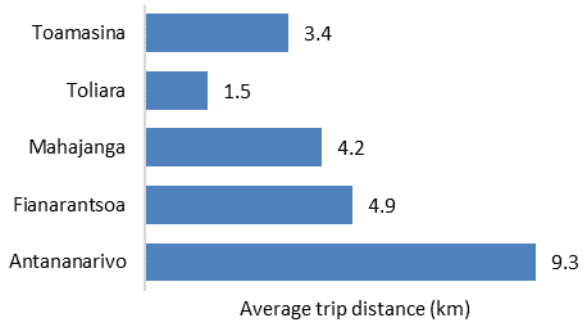
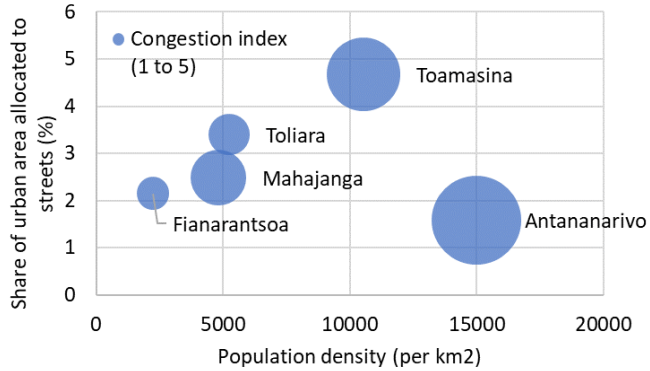


Figure 27. Congestion Assessment (1 to 5)

Figure 28. Population Density, Transport Infrastructure and Congestion



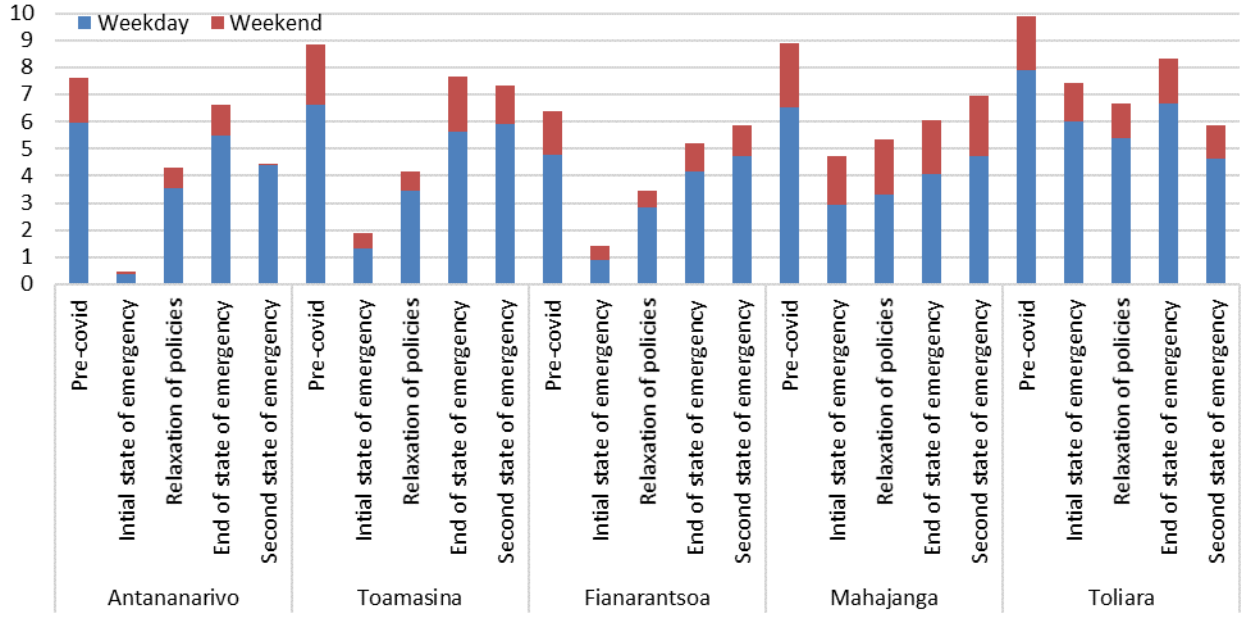
Resilience of Transport Services to External Shocks[12]

The current COVID-19 pandemic reveals that the public transport services in Madagascar are highly vulnerable to external shocks, such as weather, accidents, special events, and large-scale transmissive diseases. Since the COVID pandemic, Antananarivo has been faced with most significant challenges in terms of mobility among Malagasy cities. On March 21, 2020, the Government declared a state of emergency, suspending all local and regional public transport services. In late April, taxi and taxibe were allowed to operate with limited capacity and with sanitary measures. In October, the state of emergency was lifted. During the restriction period, the people's daily mobility was significantly constrained. In particular in Antananarivo and Toamasina where local transit was significantly restricted, the average number of trips per week was sharply dropped (**figure 29**).

For many operators, the revenues were dropped to one-tenth of the pre-COVID level. Many operators have been able to repay their loans. Even after all restrictions were lifted off, regional and local public transport revenues have not returned to their pre-COVID levels, suggesting its long-term impacts. Through the two states of emergency causing complete or partial suspension of public transport, about 20,000 jobs have already been lost in the national, regional and local bus and taxi sectors.

To strengthen resilience to unexpected external shocks, additional policy measures may need to be built in the public transport systems. This is of particular importance to Antananarivo where the population density is high and public transport is highly congested. In April 2021, the COVID cases surged again in Madagascar. When the Government declared the second state of emergency, the people's mobility in Antananarivo was severely curbed once again, while other cities were less affected.

Figure 29. Average number of trips by local residents in selected cities during the COVID crisis



[12] For a more detailed discussion, see CPCS (2021b).

Chapter Summary

Key takeaways from this chapter are as follows.

- Madagascar has been experiencing rapid urbanization in recent years.
- Antananarivo, the primary city in the country, continues growing vigorously. Half of the country's urban population lives in Greater Antananarivo.
- Other secondary cities, such as Toamasina and Mahajanga, are also growing but still relatively small.
- Access to Antananarivo is important for everyone, through the major national roads.
- Because all major national roads converge on Antananarivo, the city tends to be overcrowded with too much traffic inflows attracted nationwide.
- Because of the lack of well-prepared development plans, Malagasy cities lack space dedicated to transport infrastructure.
- Antananarivo and Toamasina are estimated to use only about 5 percent of urban areas for roads, well below the international norm, i.e., 15-25 percent.
- Given the limited space for urban transport infrastructure, the transport services need to be highly efficient, however, the current transport services are poorly organized and inefficient.
- Available urban transport services (e.g., taxibe, tuk tuk, rickshaw) are mostly "informal." They are cheap but often unsafe and inefficient.
- Recent data shows that the people's transport mobility is most constrained in Antananarivo.
- The current COVID-19 pandemic reveals the vulnerability of urban transport services in large cities. The people's mobility has been most restricted in Antananarivo. Many people lost access to their workplaces. Many transport operators were also faced with a significant financial difficulty with the sharply dropped demand but continued loan payments.
- Under a well-integrated urban transport system, informal public transport can be an important solution to support people's mobility. It is important to develop a proper regulatory framework to ensure operational efficiency, safety and resilience.

III. Demand for Mobility in Antananarivo

As discussed above, Antananarivo is the most congested city in Madagascar and one of the top priorities in urban transport. The following chapters are focused on examining challenges and opportunities for Antananarivo where urban mobility is most constrained, while the city is the engine of the growth for Madagascar.

Needs for Public Transportation

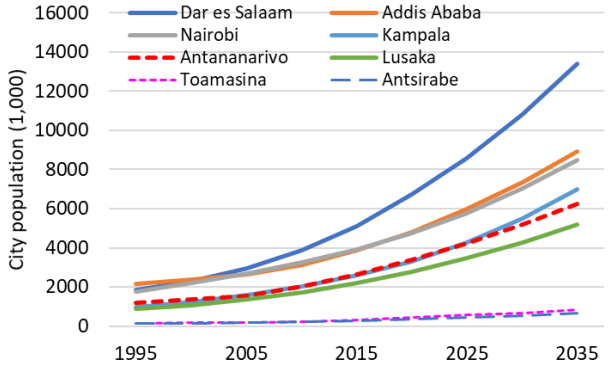
Antananarivo is one of the largest cities in the region, with a total population of 3.3 million in 2020, which is projected to be nearly doubled to 6.2 million by 2035 (**figure 30**). It is expected to continue growing at an annual growth rate of about 4 percent, which is well above the national population growth rate, 2.7 percent. Because of its attractiveness of industries and jobs, more people would likely keep flowing in Antananarivo, generating more needs for mobility of goods and people.

In Antananarivo, minibus is the most important means of public transport, while many other people just walk, not using any public transport. According to the latest household survey in the city, about half of the formal employees use minibus to go to work. 37 percent walk to their workplaces. Self-employees are more likely to walk. Still, minibus is the most important public transport (**figure 31**). The individual car ownership is still generally limited in Madagascar. In Antananarivo, only 6 percent in the sample own private cars. Motorcycles and bicycles are more prevalent: 17 percent for the former and 13 percent for the latter (Iimi 2021).

There is untapped potential demand for public transport, especially among the poor. Currently, the majority of the poor do not use public transport but walk to their workplaces (**figure 32**). However, regardless of income level, minibus is the most important transport mode. It is clear that affordability matters. In Africa, normally, households (median) spend on average 2 to 8 percent of their income on transportation (e.g., Lozano-Gracia and Young 2014) (**figure 33**). In Antananarivo, people spend on average 5.2 percent, which is already higher than the regional average. Particularly, the poor spends relatively more on transportation (**figure 34**). Based on the estimated demand function, the price elasticity is found to be relatively small at -0.05 but statistically significant especially for travelers within Antananarivo Renivohitra (CUA) (**figure 35**).[13] If public transport was more affordable (holding everything else constant), more people would likely use more public transportation. The demand seems to be inelastic to prices for users who live in suburban areas, such as Antananarivo Avaradrano, Antananarivo Atsimondrano, and neighboring districts (Arivanimamo and Ambohidratrimo). This is because there are few alternatives to use in these areas. People cannot help but use minibuses regardless of fares.

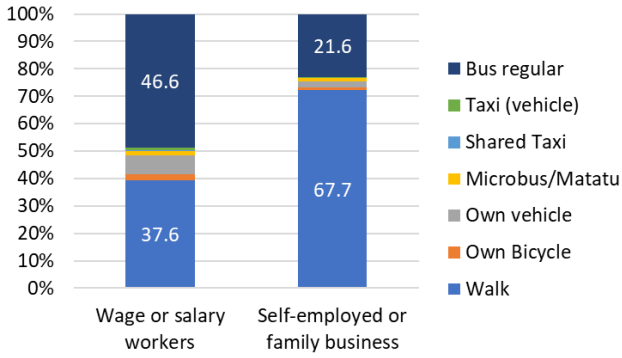
[13] See Iimi (2021) for a more detailed discussion.

Figure 30. Urban Population in Selected Cities



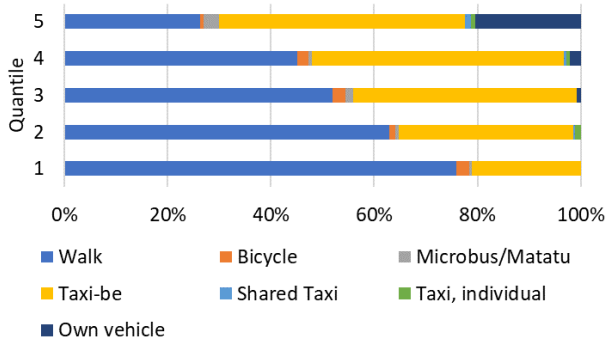
Source: UN Habitat (2018).

Figure 31. Share of Transport Modes by Employment



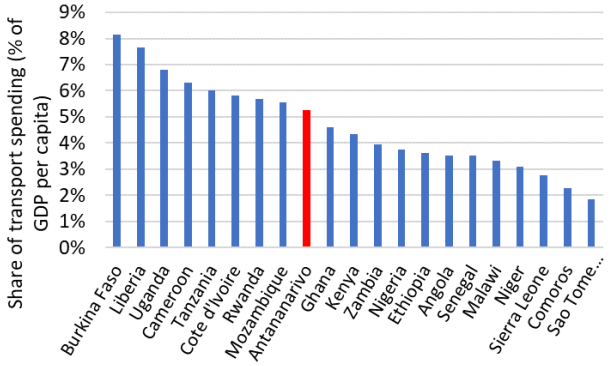
Source: Iimi (2019).

Figure 32. Share of Transport Modes by Income Group



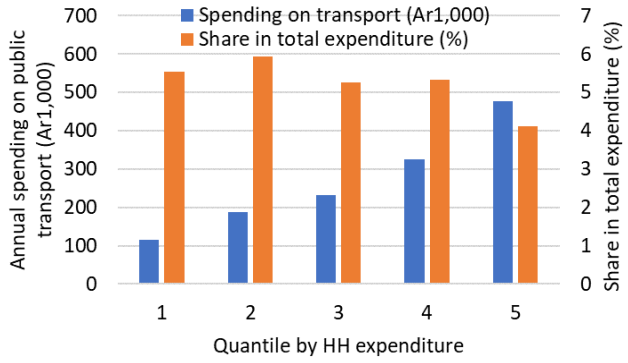
Source: World Bank (2016b).

Figure 33. Transport Spending by Households in Africa



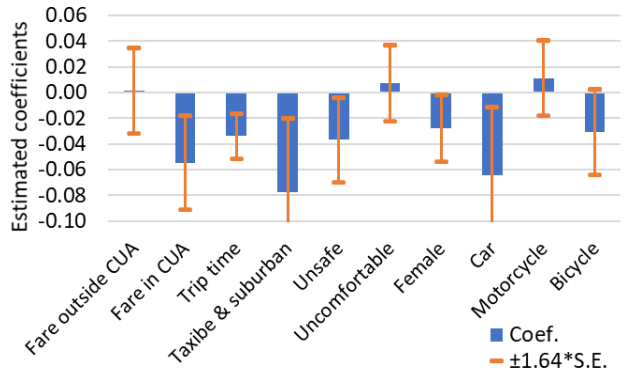
Sources: Lozano-Gracia & Cheryl (2014); World Bank (2016b).

Figure 34. Transport Spending in Antananarivo



Source: World Bank (2016b).

Figure 35. Estimated Demand Elasticities



Source: Iimi (2021).

Over-competition, Safety and Gender

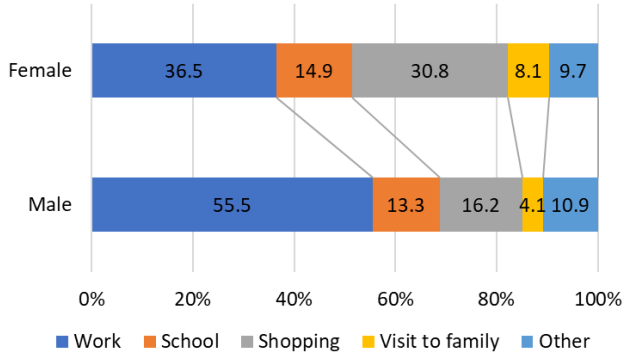
Under loosely regulated circumstance, market competition tends to become intense. Bus operators who borrow the fleet from bus owners have strong incentive to carry enough passengers to cover the rent on the bus and fuel costs, while potentially compromising basic maintenance and safety costs. Bus operators tend to compete for

each additional passenger against each other (World Bank 2021). Although the operating speed of minibus in Antananarivo is already relatively slow, bus drivers tend avoid fully stopping their bus to pick up or drop off passengers, which is very dangerous for the users.

Public transport users desire safer and more comfortable services. There are significant differences in transport demand by gender. While male passengers use minibus for commuting purposes (work or school), more female passengers use minibus for shopping as well as family visit (**figure 36**). In general, quality of service is an important determinant of the demand for public transportation. People prefer clean, safe and comfortable rolling stocks (e.g., TRL 2004; Chica-Olmo et al. 2018). In Antananarivo, a willingness pay analysis indicates that a reduction in travel time by 10 minutes would require an MGA248 increase to offset the change in utility, while gaining a safer experience from non-safe was valued at MGA93, while holding everything else constant (CPCS 2021a).

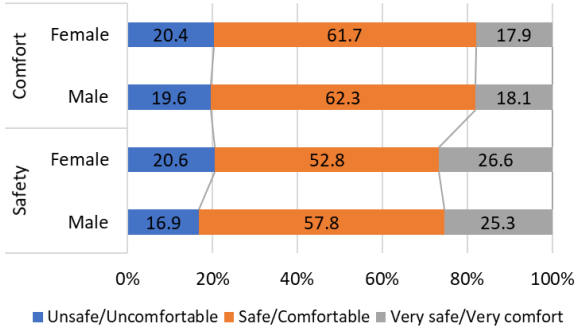
In Antananarivo, about 20 percent of minibus uses feel that the services are uncomfortable and unsafe. More women than men feel that minibus is unsafe (**figure 37**). This perception is reflected in the estimated demand (figure 32 above): The coefficient for female users is negative and significant. In addition, the demand for those who feel that minibus is unsafe is also weakened.

Figure 36. Trip Purposes by Gender



Source: Iimi (2021).

Figure 37. Quality of Minibus Service by Gender



Source: Iimi (2021).

To support the people's demand for public transport, it is required to establish a proper institutional framework to effectively impose safety regulations on minibus operations as well as fleet, while restraining over-competition among operators. The current fleet in Antananarivo is either Mercedes-Benz Sprinter or Mazda Bongo series minibus. As in many African cities, these second-hand vans are imported and converted locally for public transport. With poorly secured seats and few safety features attached, passengers are exposed to a significant safety risk (**figure 38**). The average fleet age is 23 years, well beyond a normal vehicle life of 16 years. There are only a few bus stops with proper safety measures (**figure 39**). Boarding directly from the road through the rear door guided by an on-board conductor adds to safety risks for not only passengers but also bus operators and other road users.

Figure 38. Interior View of Taxibe

Figure 39. Bus Station in Antananarivo

Mobility and Access to Jobs

Improving the city dwellers' mobility is of vital importance not only for passengers but also to support the Antananarivo's sustained inclusive growth. As in the literature, the time elasticity of the public transport demand in Antananarivo is estimated at -0.03, which is found to be statistically significant and negative (figure 32 above). Thus, a 10 percent improvement in efficiency of transport operations would result in increasing the demand for mobility by 0.3 percent. The number looks small, but when the total number of trips made each day is taken into account, i.e., 1.4 million trips per day (see below), the potential impact would be substantial. Currently, minibus users spend on average about 45 minutes on board of the vehicle (**figure 40**). While average access time to boarding point is about 9 minutes, egress time from alighting point is on average 16 minutes (Iimi 2021). The accessibility to services is fairly good, but the efficiency on board remains to be improved.

Transport mobility is essential for people to get access to well-paid jobs, which are concentrated in the center of the city. World Bank (2016a) shows that the returns to education and work in urban areas are higher than those in rural areas. The average monthly salary for commuters is about MGA276,000 or US$78, about 20 percent higher than that for noncommuters (Iimi 2019) (**figure 41**). On the other hand, the average trip cost is about MGA840 or about 25 U.S. cents per trip (**figure 42**). Thus, pursuing a better job by commuting make people better off, contributing the city's growth as a whole.

However, many job opportunities are concentrated in the center of Antananarivo (CUA) (**figure 43**). On the other hand, residential areas are distributed in suburban areas. In the middle of Antananarivo, land and housing prices tend to overshoot, pushing the poor away from the city to suburban areas. Because of the lack of efficient city transport, the poor are forced to either commute long distances every day or live in unfavorable living conditions within the city (World Bank 2017; Iimi 2019b). It is important to develop efficient transport systems connecting people's residential areas and workplaces.

Figure 40. Distribution of Travel Time (minutes)

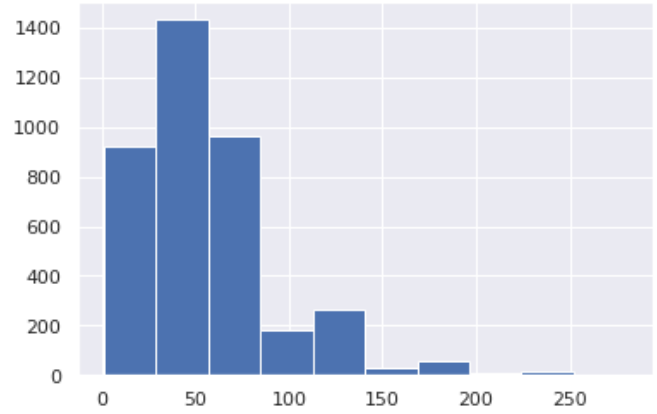


Figure 41. Distribution of Wages by Commuting

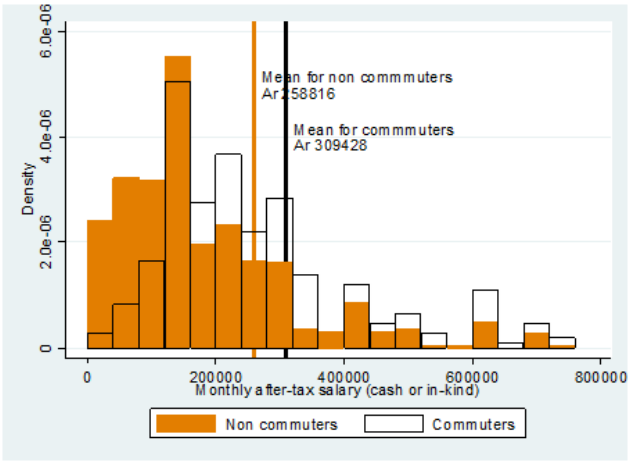


Figure 42. Distribution of Trip Costs (Ar)

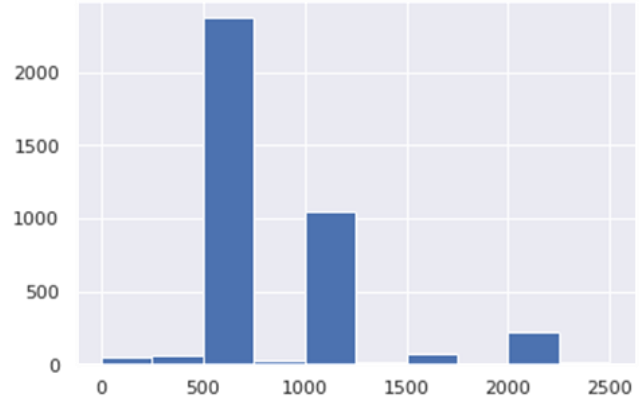
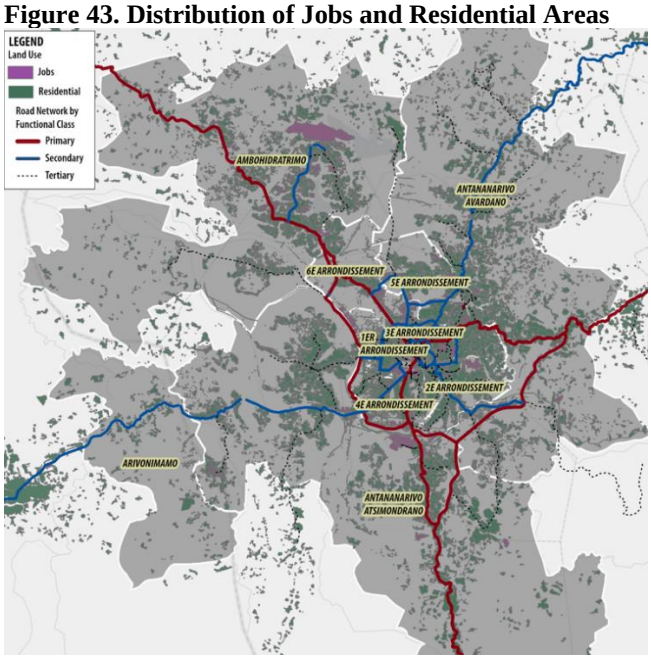


Figure 43. Distribution of Jobs and Residential Areas



Climate Change Resilience and Mitigation

Madagascar is one of the Vulnerable Twenty (V20) Group countries. Almost every year, the country suffers from significant climate events, such as cyclones and floods. The significance of casualties and other economic losses cannot be overstated. The city of Antananarivo is also vulnerable to extreme climate events. Because of poor drainage systems, the transport connectivity in the city is easily disrupted by heavy precipitation. Two-third of the city population live in vulnerable areas (e.g., flood-prone areas and/or without access to infrastructure services). Over 500 km of roads or about 16 percent of the city's total road network, including some of the major corridors connecting suburban areas to the central city, are located in flood-prone areas (**figure 44**).

Building more resilience in the urban transport system is important to not only prevent potential damages to critical infrastructure but also avoid unnecessary economic disruptions caused by extreme events. As revealed by the COVID pandemic, many city residents lost access to their workplaces because transport systems (e.g., taxibe

in Antananarivo) suspended their operations. By the same token, the climate vulnerability of the public transport services could negatively impact on the people's livelihoods and the local economy as a whole.

The reliable and efficient urban transport can contribute to not only climate resilience but also mitigation. Although the individual car ownership is minimal in Madagascar (i.e., 6 percent of the total households), it has been increasing rapidly with income growth. Globally, it is well known that the private vehicle ownership can accelerate in many countries at per capita incomes of $5,000–$10,000. In Antananarivo, the average annual wage is considered to have exceeded US$1,200. According to WHO data, the number of vehicles registered in Madagascar is estimated to be growing at an annual rate of 5 percent or more. Globally, the transport sector contributes almost one-fourth of total carbon dioxide emissions (CO2). Public transit is generally two to four times more energy-efficient than private vehicle use (**figure 45**). By promoting public transport in urban areas, Madagascar has potential to contribute to mitigating climate change as well as reducing local negative externalities, such as air pollution and road safety.

Figure 44. Flood Prone Areas and Transport Networks

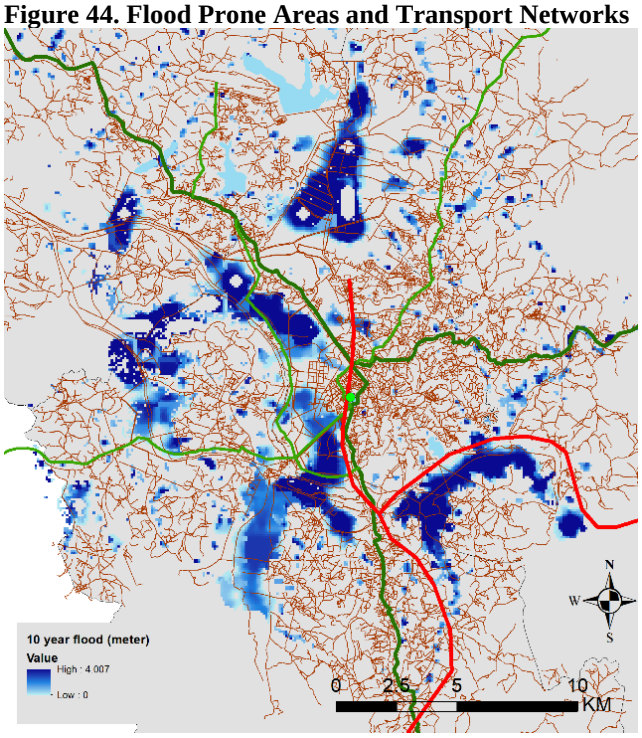
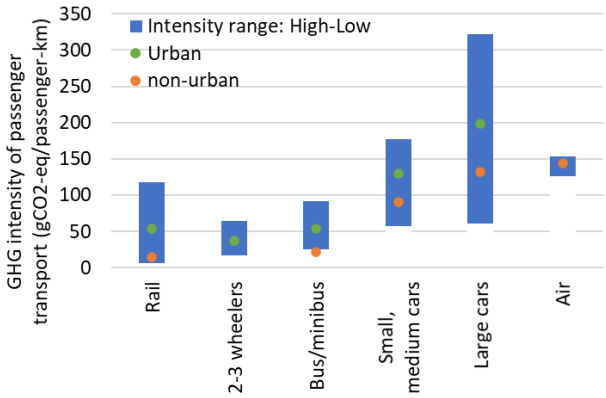


Figure 45. GHG Intensity of Passenger Transport



Source: IEA (2019).

Origin-Destination and Demand Forecasts[14]

To analyze the people's mobility patterns in Greater Antananarivo, a balanced origin-destination (OD) matrix is constructed using the zonal productions and attractions as inputs to the trip distribution model. Ten traffic analysis zones (TAZ) are considered: 8 Antananarivo districts, including Antananarivo Renivohitra (comprised of 6 districts), Antananarivo Avaradrano, Antananarivo Atsimondrano, and two adjoining districts (Arivanimamo and Ambohidratrimo) (**figure 46**). With the district population taken into account, the OD matrix is constructed based on a survey data comprised of over 4,000 respondents. It establishes the quantity of demand that requires

[14] See CPCS (2021a) for a more detailed discussion.

transportation supply and investments needed to achieve supply-demand equilibrium.

Antananarivo Renivohitra (CUA) is the center of the people's mobility. There is the significant demand for movements within CUA. The current total demand for mobility in Greater Antananarivo is estimated at about 4.2 million trips per day. About one-third of the trips have the same origin and destination zone. It is estimated that about 880,000 trips made within CUA, which presumably create significant congestion in the middle of the city (**table 1**). Within CUA, the 1st, 4th and 5th Arrondissements are popular destinations (**table 2**), however, the people's travel patters look more evenly distributed across the TAZ, indicating the demand for tangled short-distance mobility within the city.

The estimated OD matrix indicates that the between-district transport demand for commuting purposes (work and school) is also strong. There are also a substantial number of people's trips (i.e., two-thirds of the total demand) between CUA and other suburban districts every day. This highlights the importance to improve interface between the two networks: within-city taxibe and suburban buses. Suburban dwellers are often served poorly because suburban buses cover a much limited service area. In addition, it is a burden to make a transfer between within-city and suburban busses. Iimi (2021) shows that the transport demand is negatively affected when people use both taxibe and suburban buses. This indicates that the two networks are poorly coordinated. In Antananarivo, the average user transfers minibuses 1.3 times per trip. Thus, at least one transfer is needed to get to a destination. Only about 5 percent of travelers have no transfer. The current bus route networks are largely duplicated and remain to be improved to meet the people's real demand.

Figure 46. Traffic Analysis Zones (TAZ)

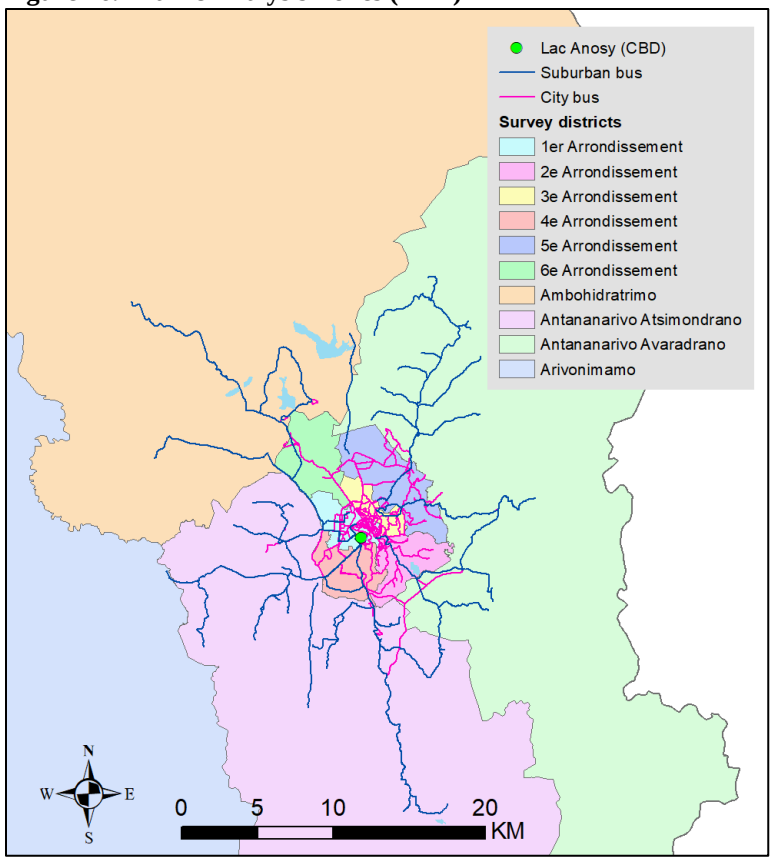


Table 1. Origin-Destination Matrix Among Districts

Origin	Destination Tana Renivohitra	Ambohidratrimo	Tana Atsimondrano	Tana Avardano	Arivonimamo	Total
Tana Renivohitra	**876,548**	302,704	262,085	374,435	218,891	2,034,663
Ambohidratrimo	230,086	**109,781**	132,137	54,114	98,874	624,992
Tana Atsimondrano	357,503	55,078	**143,852**	95,895	63,687	716,015
Tana Avardano	209,315	110,313	190,517	**174,962**	83,253	768,360
Arivonimamo	37,647	14,976	21,146	16,110	**10,660**	100,539
Total	1,711,099	592,852	749,737	715,516	475,365	4,244,569

Source: CPCS (2021a)

Table 2. Origin-Destination Matrix Within Antananarivo Renivohitra (CUA)

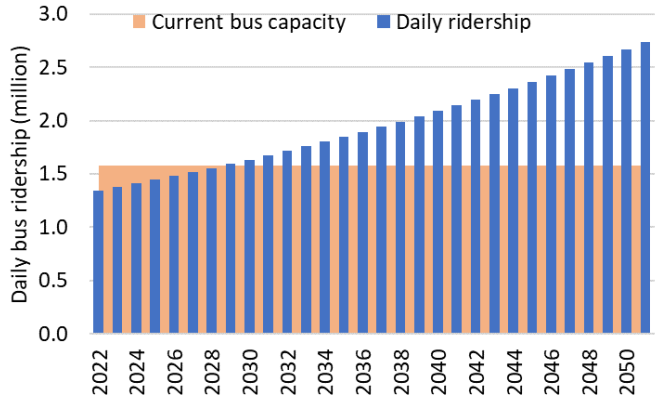
Origin	Destination 1er arrond.	2e arrond.	3e arrond.	4e arrond.	5e arrond.	6e arrond.	Total
1er arrondissement	**39,000**	27,884	21,497	38,532	47,918	20,947	195,778
2e arrondissement	23,605	**20,735**	15,526	25,676	30,500	10,253	126,295
3e arrondissement	15,366	14,295	**10,451**	13,466	27,540	8,819	89,937
4e arrondissement	33,875	25,694	17,325	**36,230**	45,306	15,924	174,354
5e arrondissement	33,880	25,327	22,923	39,831	**55,264**	21,737	198,962
6e arrondissement	19,739	14,524	8,754	17,643	18,972	**11,590**	91,222
Total	165,465	128,459	96,476	171,378	225,500	89,270	**876,548**

Source: CPCS (2021a)

Under the standard assumptions, the current minibus capacity would likely be exceeded by the people's daily demand by 2029. Under the baseline scenario, it is assumed that the current modal split is fixed, i.e., 38 percent of the total trips are carried by minibus. Then, the current minibus ridership is 1,344,000 trips per day. This is assumed to grow based on an expected long-term population growth rate (2.5 percent). The demand for minibus transport would be doubled to 2.7 million rides per day by 2051 (**figure 47**).

To meet the increasing demand, the supply capacity of public transport needs to be augmented. Since available urban space allocated to transport infrastructure has already been limited, there is no other way than intensifying the use of public mass transit. As in other countries, the private vehicle ownership looks growing as household income increases. However, that path would not be sustainable and would just keep aggravating traffic congestion. The current minibus capacity is estimated at 1,586,000 rides per day given the current normal operations and the existing old, unsafe fleet of about 6,800 minibuses. Without any measures, the current minibus capacity would fall short of the expected demand by 2029.

Figure 47. Demand Forecast for Bus Ridership



The Current Constraint of Mobility

Given the current traffic patterns, one of the most important constraints on people's mobility is traffic congestion during peak hours. There is the strong demand for daily travel between residential areas and workplaces in Antananarivo. To understand the current traffic in detail, a GPS point data collected by TAG-IP, an Antananarivo-based location intelligence firm, is used. The raw data covers over 9 million vehicles with unique vehicle identifiers and location schedules for one week from February 3 to 9, 2020 (**table 3**).

Average speeds in CUA are substantially low at 10-15 km/h during both morning and evening peak periods. Average speeds for the entire study region are 21.8 km/h for the morning peak from 7 am to 10 am and 22.3 km/h during the evening peak from 7 pm to 10 pm. Free flow speed overnight is 25 to 50 km/h. In suburban areas, it is particularly fast (**figure 48**).

Although traffic congestion is becoming more and more chronic in GA, actual congestions occur at particular points during the peak hours. The entire road network is not necessarily congested. By comparing the average speeds between the peak and off-peak hours, particularly congested points are identified: There are 104 points during the morning peak and 59 during the evening peak. 28 road segments where minibuses are currently operating are found to be congested during both the morning and evening peak (**figure 49**). By addressing these hotspots, the people's mobility is expected to be improved substantially.

In developing countries, not only inadequate roads but also poor traffic management often lead to congested streets despite their low to medium motorization levels. Intersections congest because intersecting traffic flows do not clear the intersection in an orderly manner. In developing cities, urban roads often lack proper traffic signals, pavement markings, and other instructions for drivers. Frequently, intersections become bottlenecks that generate long lines of buses, cars, and trucks. These lines congest other intersections, which in turn lead to long queues on more streets (World Bank 2021).

The identified congestion points in Antananarivo are closely related to the people's commuting patterns between CUA and suburban areas, and thus, concentrated along the major national roads. Congested areas are observed particularly around the borders between CUA and suburban districts, i.e., before and after the major national roads cross the boundary of CUA. This is where the road network converges intensively toward the center of the city and where the two bus networks (taxibe and suburban) are merged. Thus, the first priority should be put on improving the interface between the two bus networks, while diverting unnecessary traffic to the outside of the city.

Table 3. Sampled Vehicle Types in TAG-IP Data

Vehicle Type	Number of Vehicles	Percentage of Total	Avg. speed (km/h)
Bus	157,676	2%	25
Car	5,629,241	62%	18
Motorcycle	1,144,863	13%	18
Person	1,212	0%	5
Train	7,137	0%	18
Truck	2,160,773	24%	20
Watercraft	686	0%	11
Total	9,101,588		16

Figure 48. Average Traffic Speed (km/h)
(Morning peak hours 7-10am) **(Evening peak hours 4-7pm)** **(Overnight 1-5am)**

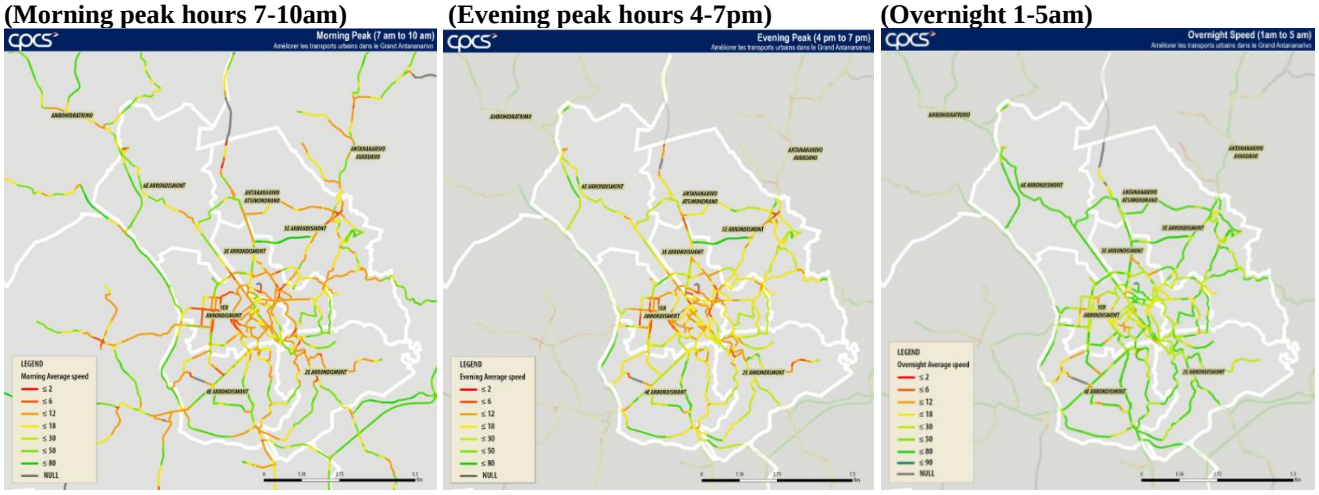
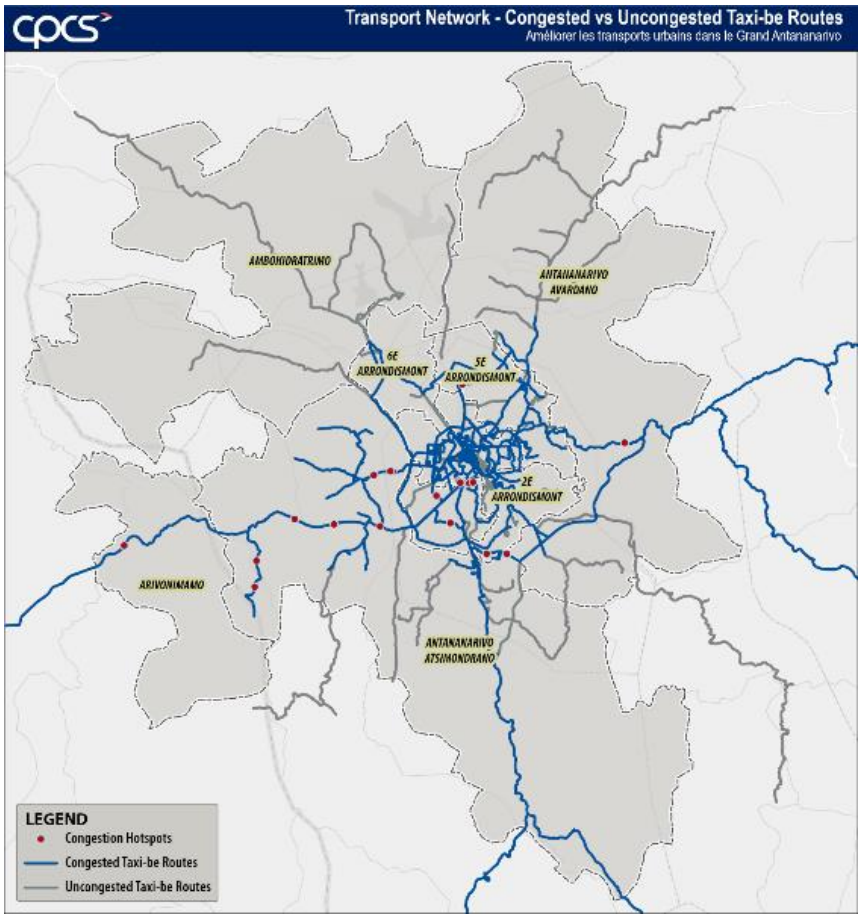


Figure 49. Identified Congestion Points



Chapter Summary

Key takeaways from this chapter are as follows.

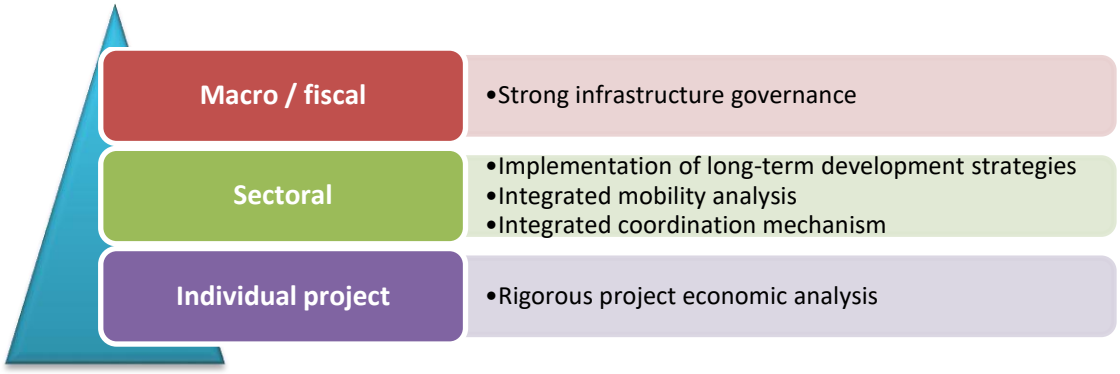
- Antananarivo is one of the largest cities in the region and the most congested city in Madagascar, with a total population of 3.3 million in 2020, which will be doubled to 6.2 million by 2035.
- Minibus is the most important means of public transport for people. Half of the formal employees use minibus to go to work.
- There is untapped potential demand for public transport, especially among the poor. 37 percent walk to their workplaces.
- Improving the city dwellers' mobility is of vital importance for workers and local businesses. The average monthly salary for commuters is about 20 percent higher than noncommuters.
- The estimated demand function shows that more people would use public transport if fares are lowered and inefficiency (i.e., time on board) is reduced.
- Users also desire safer and more comfortable transport services. 20 percent of minibus uses feel that the services are uncomfortable and unsafe.

- It is urgently required to establish a proper institutional framework to effectively impose safety regulations on minibus operations as well as fleet, while restraining over-competition among operators.
- The constructed OD matrix reveals that Antananarivo Renivohitra (CUA) is the center of the people's mobility. About one-third of the overall trips or 880,000 rides are made within CUA, which presumably create significant congestion in the middle of the city.
- There are also a substantial number of people's trips (i.e., two-thirds of the total demand) between CUA and other suburban districts for commuting purposes (work and school). This highlights the importance to improve interface between the two networks: within-city taxibe and suburban buses.
- The current demand for minibus transportation is about 1.4 million trips per day. The current supply capacity based on 6,800 old, unsafe minibuses is estimated at 1.6 million trips.
- In the next 30 years, the demand for bus transport is projected to increase to 2.7 million trips per day. The current capacity would fall short of the expected demand by 2029.
- Since available urban space allocated to transport infrastructure has already been limited in Antananarivo, there is no other way than intensifying the use of public mass transit. The private vehicle ownership looks growing as household income increases. However, it is not sustainable to rely on private vehicle use.
- There is potential contribution to climate change mitigation if the public transit system is used more. Although the private car ownership is currently minimal in Antananarivo (i.e., 6 percent), it could increase rapidly, as experienced in other developing cities. Public transit is generally two to four times more energy-efficient than private vehicle use. Regardless of income level, the vast majority of transport users would likely continue to rely on minibuses.
- Given the current traffic patterns, the most important constraints on people's mobility is traffic congestion during peak hours.
- The current congestion occurs at particular points during the peak hours. The entire road network is not necessarily congested. By addressing these hotspots, the people's mobility is expected to be improved substantially.
- The interface between CUA and its neighboring districts is particularly congested along the major national roads. This is consistent with the people's commuting patterns.
- A holistic approach is needed to ensure efficient connectivity between the two bus networks, while diverting unnecessary traffic to the outside of the city.

IV. Toward Improving Urban Transport in Antananarivo

To meet the rapidly increasing demand for urban mobility effectively and efficiently, a holistic approach is needed at different levels (**figure 50**). At the macroeconomic and fiscal level, a sound governance structure for public investment needs to be put in place. At the sectoral level, it is important to not only prepare but also implement an overall development vision consistently over the long term. To ensure the vigorous and sustainable implementation of development strategies, it is useful to establish an integrated regulatory authority or coordination mechanism consolidating available human and financial resources. At the individual project level, it is essential to carry out rigorous project economic analysis to prioritize projects and verify their economic viability. This chapter confirms basic principles of these aspects and provides an overview of the Government's current programs and other potential interventions, exploring complementarities to maximize the synergy among the projects.

Figure 50. Overall reform principles for better urban transport investment management

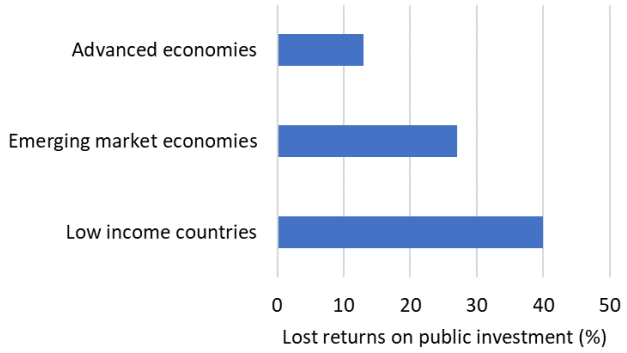


Improving Infrastructure Governance

Given the massive financing needs for urban transport infrastructure, it is essential to have a solid, evidence-based, systematic mechanism to prioritize, select and implement priority public investments. It is of particular importance to build a system to process and evaluate unsolicited proposals. In recent years, Madagascar has embarked upon new important urban transport projects in Antananarivo, including ring roads, bypass, cable cars, and urban rail transit. Unfortunately, however, they are often fragmented and poorly coordinated without assuring any clear long-term vision of urban development. Some of them seem to lack rigorous assessments to ensure economic feasibility and environmental and social sustainability. The importance of infrastructure governance cannot be overemphasized in developing countries. IMF (2019) estimates that about 40 percent of the returns on public investment are lost because of inefficiencies of public investment management (**figure 51**).

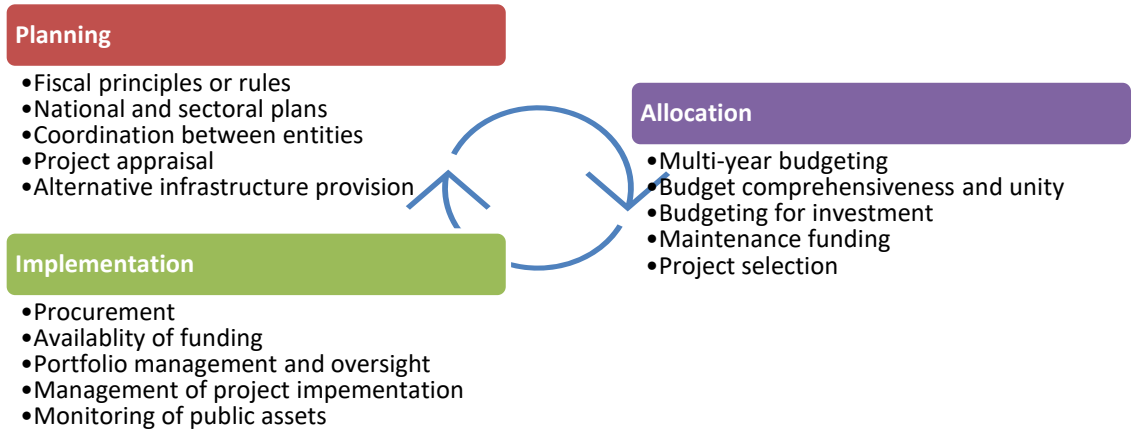
Common areas of concern are project prioritization and project appraisal. Inefficiencies are caused at different stages, from planning to allocation and implementation (**figure 52**). In Madagascar, infrastructure governance looks particularly weak in the planning and allocation phases. Effective investment planning requires a solid institutional framework based on sound fiscal principles and reliable national and sectoral development plans. Since available resources are often limited, the capacity of assessing feasibility of investment and coordinating different ministries and entities is particularly important. To maximize benefits from investments, it is required to allocate available resources consistently and comprehensively by assuring not only investment but also maintenance expenditures over the medium term.

Figure 51. Loss of returns on public investment (percent)



Source: IMF (2019).

Figure 52. Public Infrastructure Management Assessment (PIMA) Framework



Source: IMF (2019)

Implementing Strategic Plans, with Well-defined Objectives and Policy Principles

To improve infrastructure governance in the urban transport sector, first, it is important to not only prepare but actually implement a long-term urban development strategy consistently. In Madagascar, there is a significant implementation gap. Well-prepared urban development and transport studies exist, however, their implementation is often delayed or not realized at all. In the urban sector, a comprehensive urban agglomeration and development study for Antananarivo and Toamasina (TaToM) was prepared in 2020, following which the urban transport master plan (Etude du Schema Directeur du Transport dans la Ville d'Antananarivo, SDT) has just been developed in December 2021. These studies include ambitious investment plans.

The urban transport master plan (SDT) proposes a phased approach to (i) develop ring roads and priority urban roads connecting suburban areas to the center of the city, (ii) rehabilitate and extend urban rail lines, and (iii) introduce cable car lines. It envisages ambitious investments of over 1.4 billion euros for the next two decades (**table 4**). Over the medium to long run, the master plan also suggests to develop bus rapid transit (BRT) and other mobility services. It remains a challenge how to implement the plan with all relevant projects aligned. The Government has recently embarked upon several important urban transport programs, which are included in the

master plan. However, they are still fragmented and can be coordinated better with other potential complementary interventions.

Table 4. Investment needs in Urban Transport Master Plan

	Road	Rail	Cable car	Total
Phase I: 2021-25	323	60	135	518
Phase II: 2026-30	313	58	70	441
Phase III: 2031-35	115	250	0	365
Phase IV: 2036-40	111	0	0	111
Total	862	368	205	1,435

Source: ATT (2021).

Need for More Integrated Approaches for Urban Mobility

A more integrated approach focused on people's mobility is worth considering with a wider range of economic benefits from urbanization and agglomerations taken into account. The proposed urban transport master plan for Antananarivo is heavily concentrated on physical infrastructure investments, including roads, railway and cable cars, which are necessary but not sufficient to support sustainable mobility in the urban sector. International experience shows that road capacity expansion, i.e., more and wider roads, bypasses, and intersection improvements in the form of flyovers, may not be a good long-term strategy. Managing motorization and encouraging the use of much more carbon efficient modes, such as public transport, including 2- or 3-wheeler, bus, or train, biking and walking is fundamental to a low-carbon development trajectory while supporting sustainable development goals for livable cities, social inclusion, clean air, and road safety (World Bank, 2019b; 2021).

It is useful to prepare a comprehensive urban mobility study. Complete streets (CS), multimodal streets (MS), and integrated corridor management (ICM) are useful to manage traffic flows from all road users, including pedestrians, bicycles, buses, private motorcycles and cars, and trucks (**box 1**). As in many other developing cities, Antananarivo has not built complete streets because the sidewalks were often not built, and cars park or shops are built in this space. Combining complete streets with other road improvements, traffic management, parking policies (**box 2**)and public transport priority in key corridors, the ICM approach can facilitate the overall mobility in urban areas.

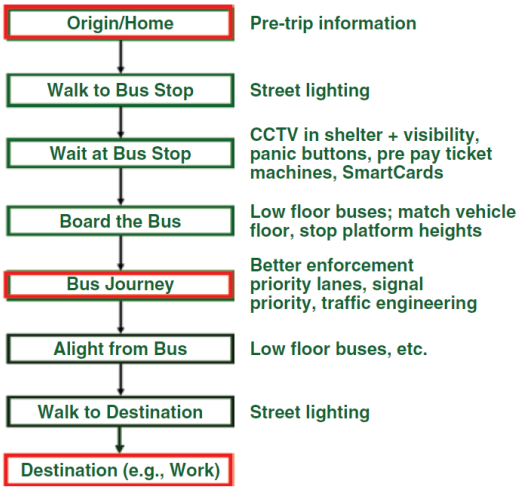
Box 1. Integrated Corridor Management and Complete Streets

The Integrated Corridor Management (ICM) approach aims at using roadway infrastructure and public transport supply to move the most people safely, efficiently, and reliably with minimum environmental effects, without proportionally compromising the same for private vehicle users. It includes not only motorized and nonnormalized transport infrastructure and public transport but also other traffic management policies, including pedestrian and junction facilities. The ICM approach takes into consideration not only public transport, which used to be a traditional area of focus in the urban transport management, but also the entire journey from every origin to every destination, including access and egress to the transport systems (**figure 53**). Successful examples of ICM can be found in New York, Dublin, London, Manchester, Seoul and Wuhan, the capital of Hubei Province, China (**figure 54**) (Zimmerman et al., 2012).

Roadway management needs to include development of sufficient arterial roads designed based on complete streets principles to accommodate diverse modes including walking, bicycling, public transport, automobiles

and heavy trucks. Urban streets should be managed to favor more sustainable modes, with wide sidewalks and crosswalks, bike- and bus-lanes, low design speeds, and traffic calming. To ensure universal access to streets, all streets require dedicated slow zones that are accessible to pedestrians—whether in the form of dedicated pedestrian sidewalks or slow-speed shared spaces (**figure 55**). Sidewalks need to be level, free of obstacles, and well maintained with curb ramps at intersections. Traffic calming measures, such as raised crosswalks, narrower lanes, restrictions on free turns, and speed bumps, improve pedestrian safety. Crossings are made safer with pedestrian islands, curb extensions that minimize crossing distances, signals, and other traffic safety mechanisms (World Bank 2019b).

Figure 53. Whole journey concept

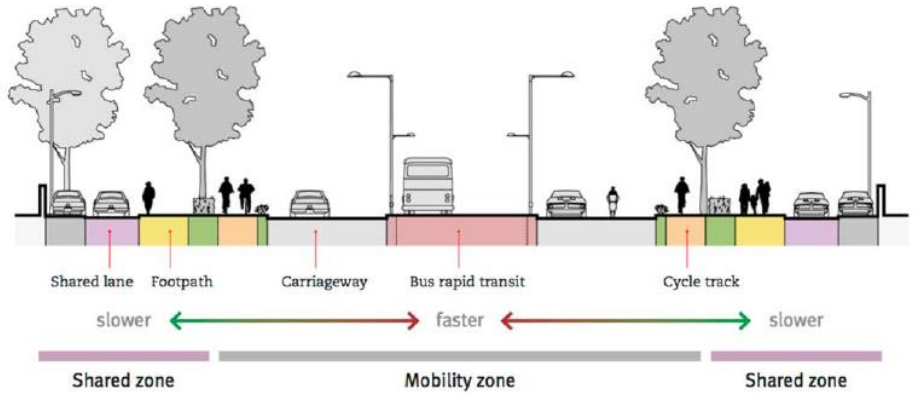


Source: Zimmerman et al. (2012).

Figure 54. London queue jumper "Virtual bus lanes"

Source: Zimmerman et al. (2012).

Figure 55. Slow zones and safe spaces for pedestrians



Source: World Bank (2019b).

Box 2. Parking management in Yaoundé and Abidjan

Parking policy is an important element of urban traffic management and the ICM approach. Poor parking management compromises the usability of city center sidewalks in many cities. These problems are particularly acute in the city centers of Abidjan and Yaoundé. Vehicles are often parked within pedestrian spaces, damaging the quality of facilities and turning public space into storage for private vehicles. Vehicles parked on sidewalks limit their usability for pedestrians and forces citizens to walk in the roadway with motor vehicles. Parking spaces must be properly managed to ensure that cars are parked in their proper spaces. Besides preventing cars from being parked on sidewalks, proper parking management schemes can generate revenue for cities that can be used to fund the construction of pedestrian facilities.

In Abidjan and Yaoundé, sidewalk parking has been officially sanctioned, thereby legalizing parking encroachments that severely restrict pedestrian movement. Municipal governments allow businesses to reserve adjacent parking spaces, including spaces that are striped directly on sidewalks, in return for an annual fee. Even after Abidjan carried out a major investment in pedestrian sidewalks, cars have been allowed to park on the new, high-quality sidewalks (see images below). Moving forward, it will be essential to adopt parking management practices that ensure that the alignment of on-street parking areas leaves sufficient clear space for pedestrians.

Source: World Bank (2019b).

Creating Champions for Reforms

To assure the vigorous implementation of the development plans vigorously, it is of particular use to create champions for necessary institutional reforms. In Madagascar, there is a critical gap between the large-scale planning studies prepared by international consultants and their adoption on the ground by the public bodies involved in the mobility sector. For instance, although an urban transport master plan was prepared in 2004, its recommendations have never been followed up. Among others, one of the important institutional constraints hampering the vigorous implementation of long-term development strategies is that the government responsibilities and human and financial resources are still fragmented among different entities.

Global experience indicates that it is important to establish a strong institutional coordination mechanism governing urban transport issues across different jurisdictions. Jurisdiction over urban transportation issues in Sub-Saharan Africa typically extends across multiple tiers of government, creating jurisdictional impediments to integration. Lack of clear mandates and overlapping responsibilities among multiplicities, departments and agencies for planning, regulating, managing and financing make it difficult to address rapidly growing congestion and other negative externalities in megacities (World Bank 2020).

In Madagascar, different ministries and agencies work on different programs on a fairly ad hoc basis (**box 3**). In Greater Antananarivo, there are different ministries and agencies responsible for urban transportation, of which two entities play a particularly important role in regulating urban transport: Urban Commune of Antananarivo (CUA) in the urban area and Agence des Transports Terrestres (ATT) under the Ministry of Transport in the suburban area (**table 5**). This dual management creates a lack of clarity in the distribution of responsibilities, keeping available, though limited, financial and human resources fragmented. Under the poorly regulated environment, the public transport networks look inefficient with a lot of duplicated routes, resulting in overcompetition among service providers.

On the infrastructure side, there is also a mismatch of responsibilities and beneficiaries. Most of the transport infrastructure is built and financed by the national authorities (Ministry of Land Management and Public Works).

But main users are local operators and passengers. For instance, the construction and concessioning of bus stations and terminals is a responsibility claimed by both the ATT and the CUA. This is one of the sources of tension between local and national authorities.

To consolidate human and financial resources and elevate the institutional capacity in the sector, it is important to establish a national urban transport authority. Under this agency, all the responsibilities for urban transport at both national and local levels should be consolidated. The creation of such an agency will help to simplify regulatory procedures and avoid unnecessary confusion or duplication. Given the current dual regime (i.e., ATT and CUA), there are several possibilities to consolidate the existing organizations (**table 6**). While creating new authorities may be seen as a long-term goal, given the time-consuming process of legally and practically establishing new authorities in each city, it is useful in the short term to work within existing agencies to develop the necessary capacity (**box 4**).

Table 5. Roles and Responsibilities in Minibus Sector in Antananarivo

Level	Role	Urban taxibe	Suburban bus
Strategic (High-level objective and available resources)	Planning	Ministry of Transport CUA	Ministry of Transport ATT
	Infrastructure	CUA	State; Ministry of Transport
	Rolling stock	Private sector	Private sector
Tactical (Regulatory framework for the operation of the service)	Regulation	CUA	ATT
	Enforcement	DGSR; Gendarmerie	DGSR; Gendarmerie
Operational (Daily operation of the service)	Traffic management	CUA	DGSR; Gendarmerie
	Operation & maintenance	Operators; UCTU	Operators; UCTS

Table 6. Pros and Cons of Establishment of National Urban Transport Authority

	MoU between CUA and ATT	Steering committee across communes	Regulation by local office of ATT
Advantage	• No need to create any new entity • Cost effective to implement	• Legitimate to the existing local government structure • Consistent with the decentralization process	• Strong technical expertise • Accumulated experience of transport management
Disadvantage	• Nearly status quo • Unchanged dual management scheme • Few efficiency gains	• Political risk remains • Weak technical expertise • Administrative costly to establish a inter-governmental structure	• Contradict to the decentralization trend • Weak legitimacy of regulations by ATT • Administratively costly to organize such a mechanism
Performance	Independent	Legitimate	Competent

Box 3. Fragmented and duplicated urban transport responsibilities in Madagascar

There are different public agencies that play different roles in the urban transport sector, notably, in the bus transport sector in Greater Antananarivo:

The Ministry of Transport and Meteorology, through the Land Transport Directorate, defines the national sectoral policy and contributes to the related legal and regulatory framework. The 2005 law entrusts the Ministry with the responsibilities for strategic infrastructure planning, regional programming of public

investments, monitoring and control of public investment execution, supervision of implementation of regulations, and supervision of decentralized, delegated, or conceded services. To promote fair competition in the land transport sector, the Ministry does not intervene directly in the regulation and implementation of public policies, which are outsourced to autonomous executive agencies, notably, the ATT. The Ministry is no longer involved in setting transport tariffs, although the cooperatives are still required to inform it of any tariff changes.

The Land Transport Agency (ATT) is the agency responsible for the regulation of road transport services outside of the urban commune of Antananarivo. Operational since 2007, its powers have been progressively reinforced in the field of passenger transport. It is responsible for regulating and monitoring public transport operations, promoting the private sector development in the transport sector, granting concessions, and managing the services it provides. To this end, the ATT is also responsible for assuring safety and security of transportation, and constructing, maintaining and managing suburban bus terminals (through contractors/concessionaires.

The Urban Commune of Antananarivo (CUA) is given the powers in the field of transport are based on the decentralization laws. It is responsible for the creation and management of roads, parking areas and transportation services in its jurisdiction. The Direction des Transports et de la Mobilité Urbaine organizes the taxi-bé business in the urban area, by validating licenses for each owner, vehicle, or line, and conducting a financial assessment for the issuance of business licenses.

The National Council of Land Transport (CNTT) was created by Law No. 046/2004 and defined as a consultative body. In theory, it was intended to be composed of representatives of the State, local authorities, transport professionals, and users to represent their interest to the Government for the development and implementation of transport policies on issues related to investment, organization, and operation of the land transport system. In practice, however, it is not active. It has no official mandate within the existing institutional and regulatory framework, and therefore no real role.

The General Directorate of Road Safety (DGSR) was established by decree in 1989 and is responsible for regular checks on the conformity and technical condition of private and collective vehicles, while the gendarmerie carries out field checks. The DGRS is therefore in charge of the physical inspection of vehicles, but does not intervene in other aspects of regulation relating to the service.

The Urban Planning Agency for Greater Antananarivo (IPAM) was officially launched in June 2020 to improve urban development planning and management in Greater Tana. It acts as a platform to share knowledge and deliver expertise on urban planning matters for the CUA and 37 peripheral communes. IPAM is currently in a trial period (until 2023). It is planned that a consolidation phase (2023-2026) and a development phase (2027-2029) will follow. IPAM is not an authority with a mandate from Parliament. Although it will play an important role as a forum to coordinate and share expertise on urban development at the metropolitan level, IPAM does not have any executive mandate and depends on its members for policy implementation.

Sources: CPCS (2021).

Box 4. Different international experience of establishing urban transport authorities

A number of cities in Africa have plans to set up Unified Transport Authorities along the lines of the Land Transport Authority (LTA) in Singapore, Transport for London (TfL), the transport authority for Paris (STIF), or the Lagos Metropolitan Area Transport Authority in Nigeria (LAMATA). However, the results are at best mixed. Common key challenges include: (i) lack of financial capacity and technical know-how, (ii) unwillingness on the part of local municipalities to give up their mandates, (iii) lack of sufficient political support, and (iv) inability to

protect the interests of existing agencies impacted by creation of new authority.

Cape Town has generally benefited from clear stipulations and guidelines informing the design, financing, and management of urban transport development, although certain institutional instabilities negatively affected the capacity of delivering its bus rapid transit systems. The South Africa's National Land Transport Act (NLTA) grants to all municipal planning authorities the responsibility for "the planning, implementation and management of modally integrated public transport networks and travel corridors for transport within the municipal area and liaising in that regard with neighboring municipalities." The MyCiTi Project Office was established as a dedicated unit to perform these functions on behalf of the City of Cape Town, supported by a clear mandate, capacitated staff, and effective linkages with supplementary institutions. In 2013, the MyCiTi Project Office was incorporated into the CoCT's broader Transport for Cape Town (TCT) structure, which subsequently restructured into the Transport and Urban Development Authority (TDA) with broader responsibilities for the CoCT's transport, spatial planning, land-use management and certain housing delivery functions in 2017. However, this institutional structure was then dismantled recently and reverted to the municipality's Transport Directorate.

In the case of Lusaka, the National Transport Policy (2019) of Lusaka recommended the introduction of legislation for the establishment of a Public Transport Authorities (PTA) in all local jurisdictions. However, the Cabinet disapproved this recommendation with the suggestion to build capacity of existing institutions before creating new authorities.

In Dar es Salaam, while Dar es Salaam Urban Transport Authority (DUTA), which is supposed to have a mandate to plan intermodal integration, including BRT, has yet to be established, the Dar es Salaam Rapid Transit (DART) Agency is implementing BRT development. It was legally established to oversee DART BRT implementation and operations. However, there is a lack of clarity in legal procedures to clearly allocate roles and responsibilities for BRT development between stakeholders, and this has left the DART Agency insufficiently legally empowered to perform certain key function to maximize the value of BRT. The DART Agency also does not have jurisdiction on the land use along the BRT corridor, which could have subsidized fares through transit-oriented development (TOD).

Sources: World Bank (2020; 2021b).

Rigorous Project Economic Analysis

At the individual project level, it is essential to carry out rigorous project economic analysis, which allows to compare different potential options in a systematic manner and provide a guidance on how to prioritize public investments and which interventions should be prioritized. Common indicators that are used include: economic internal rate of return (EIRR), net present value (NPV), benefit-cost ratio and cost-effectiveness (e.g., costs per beneficiary). In Madagascar, there are many ongoing or planned urban transport projects in GA (see Appendix), however, these projects often lack rigorous economic feasibility analysis and environmental and social impact assessments, leaving them fragmented, poorly designed and not well coordinated with one another. It is critical to systematize the processes to evaluate, prioritize, appraise and execute public investments under strong infrastructure governance, through carrying out proper project economic analysis.

In the urban transport sector, there are three important projects that the Government has recently embarked upon in Antananarivo. Although their project economic analysis is not in the scope of the current report, it is important to verify their economic, environmental and social feasibility before advancing the projects:

- **Priority urban road projects.** Traffic management and priority urban road development are key to assure efficiency in overall traffic flows. The TaToM study identifies 17 priority road projects, including ring roads and bypasses. These are heavily biased toward investment in increasing road capacity. The total costs are estimated at US$230 million for the first phase and US$337 million for the second phase, respectively (**table 7**). Although the current traffic volumes around the project areas would likely justify economic feasibility of these projects, it is worth considering more integrated approaches focused on people's mobility, such as Complete streets (CS), multimodal streets (MS), and integrated corridor management (ICM) (see above). Wider economic benefits could be explored, including not only traditional benefits, such as reduced travel time or congestion, and reduced air pollution, but also improved amenity and local business development along the corridors.
- **Urban Train Project.** The existing rail infrastructure has not been used for passenger purposes since the 1980s. The Government has been considering for more than a decade the development of an urban rail project. The urban train project is included in the city's Urban Master Plan (PUDI). In February 2021, the State and MADARAIL S.A. (incumbent operator) agreed that the operation of such a service would be entrusted to a third-party operator, while the management, maintenance and rehabilitation of the railway infrastructure remains the responsibility of MADARAIL. The project aims at providing a mass transportation system to reduce travel times (with an average commercial speed of 15 km/h); reducing traffic pressure on road transport from the south to the center of the city (**figure 56**); mitigating greenhouse gas emissions and improving public health. Significant investments in rehabilitation works, approximately, US$63 million (updated), will be required to make the infrastructure operational. A proper operational and regulatory framework to supervise private operators also remains to be established.
- **Cable Car Project.** The Government has embarked upon a cable car project in collaboration with STCA as promoter and the POMA/COLAS consortium as constructor/supplier. The project aims at meeting the needs of urban mobility infrastructure by offering a low-carbon, economically competitive mode of electric transportation that avoids the constraints of elevation changes, land use, expropriation, and access to geographically isolated areas. The project first offers Line A to link the Anosy business district to Ambanidia, and Line B to link Anosy and Ambatobe passing through the city center, the Soarano station and the Ankorondrano business district. Its operation is planned to be managed thanks to a Special Purpose Vehicle composed of CUA and the promoters. The estimated investment cost financed by the French government is EUR 131 million.

Although these public transit projects are important to ameliorate the mobility in certain areas, each of them would likely be a partial solution. Based on the estimated OD matrix, the planned Urban Train and Cable Car Projects could affect only 11 percent and 6 percent of the total mobility demand in the city, respectively (**table 8**). Potential beneficiaries would likely be concentrated in relatively small areas in CUA. Of course, not everyone will use public transport. Thus, the actual impacts of the projects would be even more limited.

To address the mobility problem, citywide traffic management is essential, for which the development of efficient urban road networks is a key element. The TaToM project funded by JICA (Japan International Cooperation Agency) identified priority urban links consisting of four bypasses and six radial highways to support the efficient traffic flows and sustainable urban growth in Greater Antananarivo (**figure 57**). The TaToM project is managed by an inter-ministerial committee composed by the MAHTP (Ministry of Land Management, Housing and Public Works) headed by the General Directorate of Territorial Planning and Housing (DGATH) and the Ministry of Transport, Tourism and Meteorology (MTTM) headed by the General Directorate of Land Transport (DGTT) and aims at improving the mobility in a broader area, including not only CUA but also suburban areas, and supporting citywide inclusive growth. According to the estimated OD matrix, more than 30 percent of the total trips could potentially be affected by these priority road works (**table 9**).

Table 7. Priority Road Projects in Greater Antananarivo

No	Name of Project	Cost ($ mil)	Length (km)	Progress
Phase 1				
A-R-01	Construction of a 4-lane road between Ankorondrano and Andranonahoatra (Northern section between RN4 and RN1) (Part of the Central Ring Road including a Bridge across the Ikopa River)	60	6	Planned
A-R-02	Construction of a 4-lane road between Ampitatafika and Antsavatsava (Section of road in the South between the RN4 and the RN1) (Part of the Central Ring Road)	5	1.5	Planned
A-R-03	Construction of Primary Arterial Road between RN4 and the Hydrocarbon Road in the Primary Urban Centre of Ankorondrano	50	1.3	Planned
A-R-04	Project for the Construction of an Interchange at the Intersection of Ankorondrano of the Hydrocarbon Road and the Marais Masay Road	40	Flyover	Planned
A-R-05	Project for the Construction of a Section of the Ambodifasina - Namehana Road of the External Rocade between the Tsarasaotra Road and the RN3	10	5	Planned
A-R-06	Construction Project of Ambohimalaza - Namehana Road Section External Ring Road between RN3 and RN2	20	8	Planned
A-R-07	Construction Project for the Ambohidratrimo Urban Sub-Centre Bypass Road	5	2	Planned
A-R-08	Construction of Primary Arterial Road between Tana Masoandro and Antsavatsava	10	4	Tana Masoandro project
A-R-09	Project for the Construction of an Interchange at the Intersection of RN4 and RN1 at Anosizato	30	Flyover	Planned
A-F-01	Project for the Development of a Multimodal Goods Platform in Amoronakona	50	Terminals	Planned
A-F-02	Urban Passenger Train Development Project between Ankorondrano - Tanjombato	100	Train	Ongoing
Phase 2				
A-R-10	Project for the Construction of a Canal Road between Tanjombato and Ankorondrano	150	…	Planned
A-R-11	Project of Construction of RN3 Bypass (between the External Bypass and the Central Bypass)	30	12	Planned
A-R-12	Construction of the Anosiala - Ambatolampy-Tsimahafotsy Road Section of the External Ring Road (Northern Part)	15	10	Planned
A-R-13	Construction of Tsarasaotra Road Extension Project between Ambodifasina Urban Sub-Centre and Ambatolampy-Tsimahafotsy Sub-Centre	7	…	Planned
A-R-14	Construction of East-West Primary Arterial Road between RN3 and RN4 Bypass	25	9	Planned
A-R-15	Construction of Primary Arterial Road between Andranonahoatra and the External Ring Road	10	…	Planned
A-R-16	Construction of Primary Arterial Road between the RN4 Bypass Road and the Ampangabe Suburban Center (through Tana Masoandro Suburban Center)	80	15	Planned
A-R-17	Construction of the Alakamisy Fenoarivo - Ampangabe Road Section of the Outer Ring Road (Western Part)	20	6	Planned

Source: TaToM Report.

Figure 56. Urban Rail Project and Cable Car Project

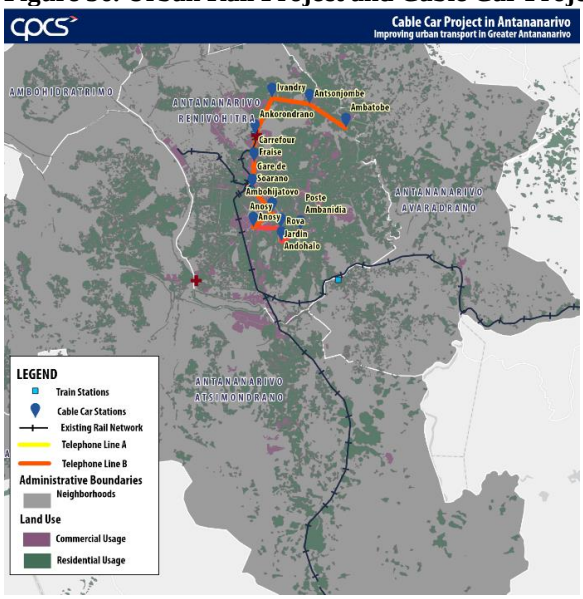


Table 8. Potential Zones Affected by New Transport Projects

	Destination (thousands per day)										
Origin	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	Total
(1) 1er arrond.	39	28	21	39	48	21	69	37	53	43	398
(2) 2e arrond.	24	21	16	26	31	10	49	65	44	21	306
(3) 3e arrond.	15	14	10	13	28	9	30	51	24	20	214
(4) 4e arrond.	34	26	17	36	45	16	55	85	49	45	408
(5) 5e arrond.	34	25	23	40	55	22	64	102	69	66	500
(6) 6e arrond.	20	15	9	18	19	12	35	34	23	24	208
(7) Ambohidratrimo	52	30	26	38	51	33	110	132	54	99	625
(8) Tana Atsimondra	46	33	23	44	47	17	55	144	96	64	568
(9) Tana Avardano	65	64	32	85	83	29	110	191	175	83	917
(10) Arivonimamo	7	2	3	5	15	6	15	21	16	11	101
Total	334	258	180	343	421	175	593	862	603	475	4245

Passenger rail (phase 1)
Cable car

Figure 57. Priority Roads in TaToM Project

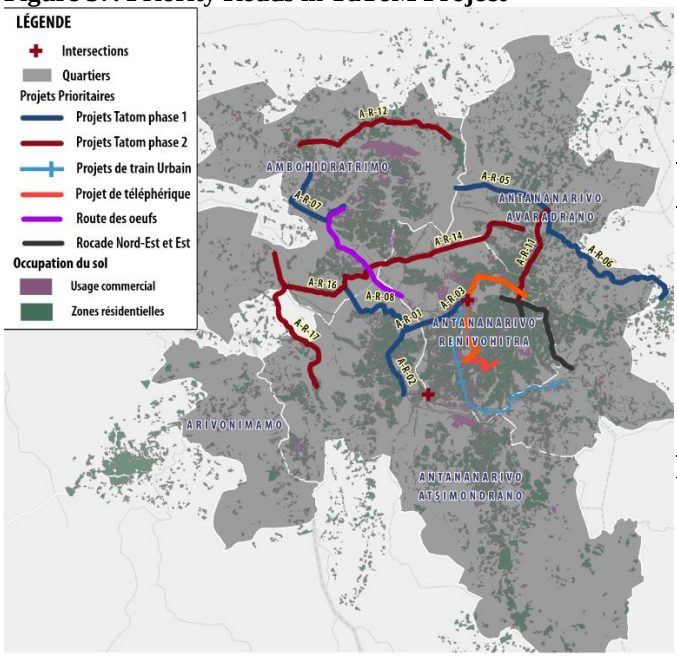


Table 9. Potential Zones Affected by TaToM Roads

	Destination (thousands per day)										
Origin	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	Total
(1) 1er arrond.	39	28	21	39	48	21	69	37	53	43	398
(2) 2e arrond.	24	21	16	26	31	10	49	65	44	21	306
(3) 3e arrond.	15	14	10	13	28	9	30	51	24	20	214
(4) 4e arrond.	34	26	17	36	45	16	55	85	49	45	408
(5) 5e arrond.	34	25	23	40	55	22	64	102	69	66	500
(6) 6e arrond.	20	15	9	18	19	12	35	34	23	24	208
(7) Ambohidratrimo	52	30	26	38	51	33	110	132	54	99	625
(8) Tana Atsimondra	46	33	23	44	47	17	55	144	96	64	568
(9) Tana Avardano	65	64	32	85	83	29	110	191	175	83	917
(10) Arivonimamo	7	2	3	5	15	6	15	21	16	11	101
Total	334	258	180	343	421	175	593	862	603	475	4245

TaToM phase 1 (AR01, 02, 03, 08)
TaToM phase 1 (AR05, 06)
TaToM phase 1 (AR07)
TaToM phase 2 (AR12)
TaToM phase 2 (AR14, 16)
TaToM phase 2 (AR11)

Comparing Other Options: Economic and Financial Assessments[15]

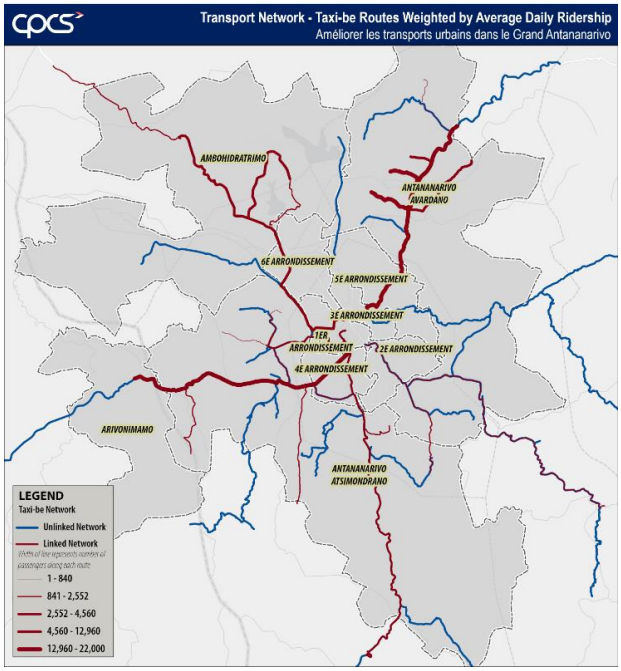
To improve the overall mobility in Antananarivo, other transport projects and interventions are also needed from a broader perspective. It should aim at not only mitigating localized congestions but also making the overall traffic flows more efficient, for example, by diverting unnecessary traffic to the outside, and incentivizing more people to use public transport.

Bus sector restructuring is an important complementary policy to improve urban mobility in Antananarivo. Bus is the most important means of transport in GA. Though the density of services differs across areas, the bus network is spread out between urban and suburban areas, covering nearly the entire city (**figure 58**). CUA implemented a pilot bus program, Urban Mobility Improvement Program (PAMU), between 2008 and 2016. The program was focused on the professionalization of the taxibe operations by creating (i) an inventory of existing urban and suburban lines and (ii) a pilot study to improve the performance of line 119 (Ankatsoa / 67 Ha). Significant progress has been made under the PAMU, including the preparation of a charter for transport operators, launching concessions of bus shelters, and a study on CUA-managed parking lots. However, the program was ceased due to a lack of political support. There is an ongoing discussion about PAMU phase 2 among stakeholders, such as CUA, CODATU and AFD. The bus restructuring program should be implemented at scale, with the bus routes optimized and more efficient fleets and safer bus stations and terminals introduced.

To examine priority interventions in this area, a project economic analysis is carried out to compare four types of interventions using the conventional economic performance indicators:

- Minibus route optimization program
- Bus fleet renewal program
- New ticketing system adoption
- Urban train project (updated)

Figure 58. Current Minibus Network



[15] See CPCS (2021a) for a more detailed discussion.

Minibus route optimization program

In Antananarivo, within-city and suburban minibuses are the main transport means that support people's daily movements. It is estimated that there are 6,714 buses on the road, composed of 4,316 taxibe and 2,398 suburban buses (**table 10**). The regulatory framework remains weak. Minibus operations are generally self-regulated by cooperatives that operators belong to. There are 44 urban cooperatives and 46 suburban cooperatives. Each cooperative normally owns 10-20 vehicles, but some operate more than 150 vehicles. The total traffic volume is estimated at 1.6 million vehicle-km per day.

Because there is no effective mechanism to match supply and demand in the market, many existing bus routes are duplicated and tangled, creating unnecessary inefficiency in operations and causing extra traffic jams along their major service routes (**figure 59**). There is no coordination between the two regulatory agencies. The operational delineation is not properly enforced. Because of the lack of fare regulations, the market is overcompetitive, causing aggressive business practices by operators.

- **Multiple routes and no hierarchy.** Existing routes are often organized as a direct service from origin to destination. There are therefore a large number of lines, operating independently of each other, which do not form a clearly hierarchical network. There are about 50 main urban lines, plus many variants. On the suburban network, the lines are organized along nine main axes (A to J), broken down into as many as 60 different lines.
- **Lack of fleet combination.** Related to the above, in Antananarivo there is no articulation between trunk lines (offering a fast service with larger capacity vehicles) and feeder and distribution lines (offering a service on secondary roads). The operations by too many small buses creates extra congestions.
- **Excessively long lines.** Excessively long routes are detrimental to efficient vehicle operation. The longer the routes, the longer the time required for a vehicle to complete a turnaround (round trip). Thus, more vehicles are needed to keep the same level of frequency. Long route operations also tend to cause cumulative delays on the route (known as a "bunching" phenomenon where vehicles are very close to each other). The reliability and efficiency of the operations are eroded.
- **Blurred delineation between urban and suburban lines.** In theory, urban lines are supposed to run inside the CUA and suburban lines outside. In practice, suburban routes extend well inside the CUA, and some urban routes extend outside. This results in duplication and overlap of routes on the main roads within the urban area, creating competition between taxibe and suburban buses. This situation also hampers effective regulation of the sector since the CUA does not have the authority to regulate suburban buses.
- **Lack of infrastructure for interconnection between lines.** In general, there is a lack of infrastructure to facilitate interconnection between the lines. Some major intersections are de facto interchanges, but the roadway is not adapted to this function. The traffic, safety, and comfort conditions for users and operators are greatly degraded as a result.
- **Lack of fare integration.** Because the routes are operated by different cooperatives and revenues are not pooled, passengers pay the fare for each trip. There is no transit arrangement. This fare system creates an incentive for passengers to avoid changing trips and paying multiple times. The lack of fare integration is a major reason for the above-mentioned multiplicity of routes.
- **Pernicious business practices.** The dominant business model in the minibus market generates many negative externalities. Drivers who do not own their vehicles are generally paid from the balance of the collected fare revenue and a fixed rent paid to vehicle owners. They thus have an incentive to carry as

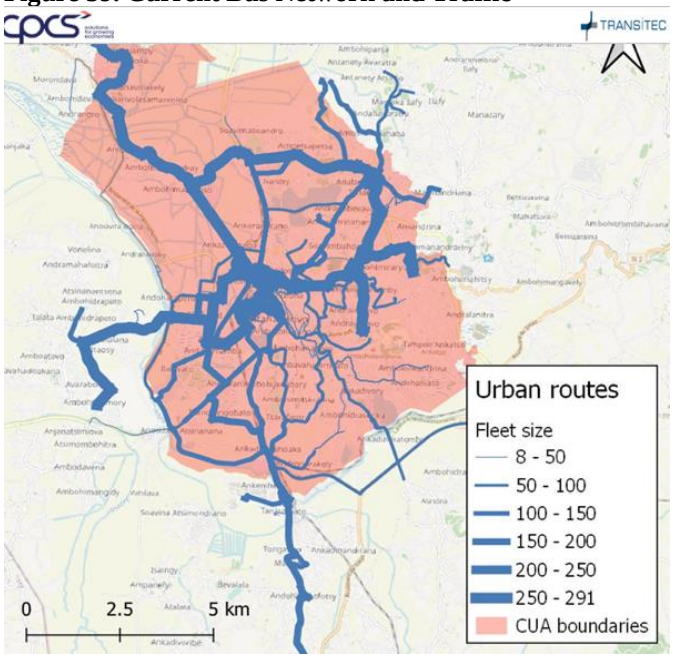
many passengers as possible per day, often compromising passengers' safety and comfort. Because of the fierce competition in the market, operators tend to overload passengers, drive aggressively, omit proper vehicle maintenance and disregard routes and schedule. Such driving practices leads to excessive fuel consumption, higher operating costs and higher emissions.

- **Low commercial speeds**. Congestion and the lack of infrastructure dedicated to public transport reduce the efficiency of bus operations. Within-city buses are heavily affected by chronic congestion. The average speed is estimated at 12.5 km/h on the main access roads to the city center during the peak period (TaToM study). In the urban area, the average speed is normally less than 15 km/h on most of the network and drops to less than 10 km/h in the middle of the city. Low speed increases travel time for users and increases vehicle operating costs and emissions.

Table 10. Characteristics of Urban and Suburban Networks

	Urban lines	Suburban lines	Total or Average
Number of lines	54	67	121
Number of vehicles	4,316	2,398	6,714
Average vehicle capacity	25.5	23.6	25
Number of trips per day	11.4	7.2	10
Vehicle-km produced per day	1,037,050	538,508	1,575,558

Figure 59. Current Bus Network and Traffic



Network optimization and simplification can bring efficiency gains in the paratransit sector, as experienced in other cities (**box 5**). It is recommended to move toward competition for the market and away from competition in the market. In competition for the market, the government competitively selects operators that must meet quality standards measured through key performance indicators (World Bank 2021).

The current duplication and inefficiency between the two bus networks could be removed by optimizing the interface between taxibe and suburban bus lines. By developing transfer terminals, passengers could transfer

seamlessly between the two networks, reducing the length of bus routes and allowing passengers to move more efficiently as a whole (**figure 60**). Nine intersections are identified given the current traffic patterns (**figure 61**). The elimination of the overlapped routes could reduce the total length of the network by 12 percent for urban lines and by 24 percent for suburban lines. The total vehicle-kilometers produced could be saved by 19 percent. The reduced traffic flows are expected to be absorbed by the optimized use of available seats. In Antananarivo, on average 17 percent of the capacity (about five seats) is unused.

Figure 60. Principles to Reorganize Taxibe and Suburban Buses

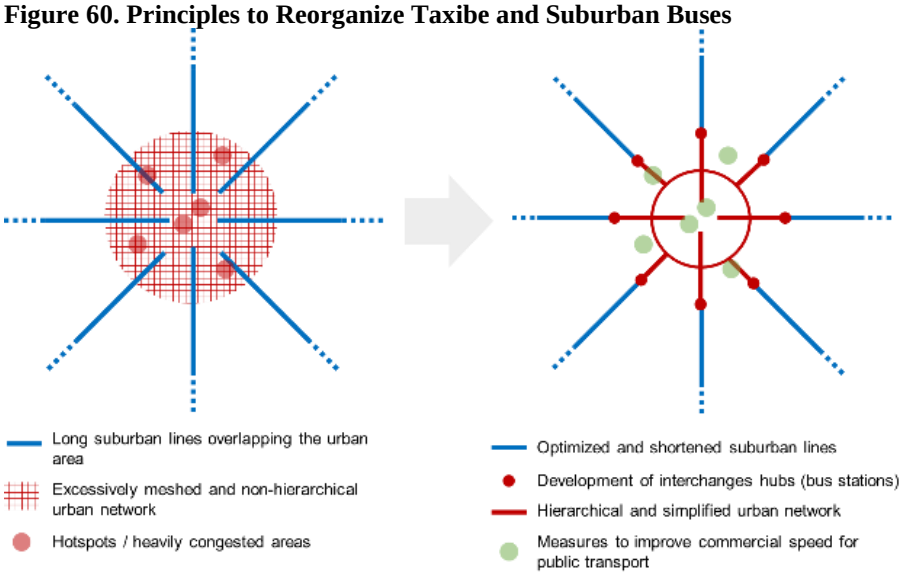
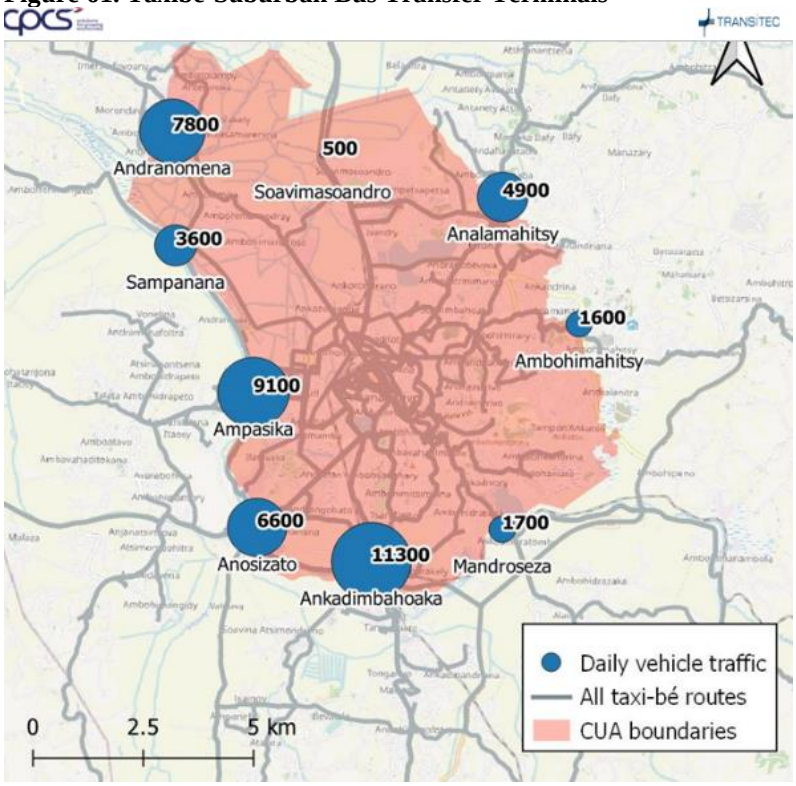


Figure 61. Taxibe-Suburban Bus Transfer Terminals



Box 5. Route simplification and operational improvements in Cape Town

The City of Cape Town has made the improvement of the minibus cab (MBT) sector a key element of its mobility plan. One of the avenues the City is exploring to achieve this goal is the transformation of MBT associations into transport operating companies. This process is based on a three-step professionalization model, which consists of (i) streamlining the transportation offering, (ii) optimizing operations, and (iii) renewing the fleet. In 2017, several minibus cab associations were selected to participate in a pilot program to improve their business models and create transportation companies, which will eventually be able to operate routes under contract with the City.

The first step in the corporatization process was to reduce the size of the fleet operated by these associations, without changing the level of service offered to users or the revenue of the operators. At the same time, the "fill-and-go" system, in which vehicles leave their home stations only when all seats are occupied, was abandoned and replaced by a system of scheduled departures, organized by "timers" paid by the transporters. This transition was made possible by the implementation of a series of organizational and operational reforms. First, drivers are paid a fixed daily fee, rather than a variable fee that encourages them to take more risks to complete as many trips as possible. Second, the routes of the lines were fixed, and new variants of existing routes were officially introduced. Drivers were instructed not to deviate from these routes or to backtrack to pick up additional passengers. Prior to the pilot, vehicle routes could vary by driver and time of day, making access to the service unpredictable for riders. Third, a comprehensive graphing exercise was conducted with the help of a public transport operations specialist. Dispatchers and controllers were positioned at stations and at specific checkpoints along the routes to ensure that drivers were adhering to their schedules.

This new model has resulted in a significant improvement in the efficiency of transport services: a 50 percent reduction in the fleet used (without a reduction in the number of passengers transported), a 45 percent reduction in fuel consumption (thanks in particular to the adoption of a more flexible driving style), and a switch to fixed working hours for drivers, from the previous average of 12 hours to 7.5 hours per day on average, improving their working conditions substantially.

Source: CPCS (2021).

Bus fleet renewal program

To wisely use the limited land space dedicated to transport infrastructure in Antananarivo, it is essential to establish an operational hierarchy in the bus sector, while increasing the fleet capacity along trunk routes. Successful fleet renewal programs can promote efficient use of limited transport infrastructure, increasing the intensity, fuel efficiency and safety of public transport services provided (**box 6**). The current average fleet age in Antananarivo is already 23 years, which is well beyond a normal life of a minibus, i.e., 16 years. About 70 percent of the fleet is beyond this limit in Antananarivo. Old vehicles are normally less energy efficient. Keeping very old vehicles on the road is also costly from the maintenance point of view. A recent study shows that nearly 30 percent of the current fleet is not operational at a particular point of time. The aged fleet generates various negative externalities, such as local air pollution, noise, more greenhouse gas emissions and traffic accidents. Many of the current minibuses are second-hand vans that are imported and converted locally for public transport. They are poorly designed with seats unsecured, exposing many passengers to serious safety risks.

New buses can provide more capacity at lower operating costs (**table 11**). Under the past pilot bus program (PAMU), a technical specification was prepared and approved by the CUA for two types of vehicles (30 and 40 seats). In the following analysis, 40-seat vehicles are considered, which are 30 percent more fuel efficient and can accommodate 60 percent more passengers than those currently in service. The profitability of the new vehicles could be 35 percent higher. The global experience tells that it is important to take a phased approach: It is assumed that old minibuses would be replaced gradually with new vehicles. Over the next 30 years, a total of 5,555 current minibuses would be replaced, which are estimated to cost about US$148 million.

Table 11. Characteristics of Current and New Buses

	Current bus	New vehicle
Number of seats	25 (average)	40
Consumption per 100 km	14 liters	18 liters
Operating days/month	22 days	26 days
Passengers per day	240	408
Kms per day*	235 km	235 km
OPEX per km** (year 1)	0.30 USD	0.35 USD
OPEX per km** (year 5)	0.34 USD	0.41 USD

* After network optimization

** Operating costs are reduced for the first 100,000 kms, covered by the manufacturer's maintenance program.

Box 6. Minibus fleet renewal programs in Dakar

Dakar is undoubtedly one of the cities that has carried out the most thorough thinking on the professionalization of small-scale transport, combining both institutional and financial dimensions. In 2001, as part of a pilot program to renew the minibus fleet in the Dakar region, the Senegalese government initiated the creation of the Association de Financement des Professionnels du Transport Urbain (AFTU), which brings together 14 Economic Interest Groups (EIGs) of transporters, the relevant ministries and the Dakar Transport Authority, Executive Council of Urban Transports of Dakar (CETUD).

The first program was launched in 2005 by CETUD and aimed in particular to put in place new operating rules and facilitate access to credit for operators. The concessional loan granted by the World Bank to the Senegalese government ($16 million) was retroceded to AFTU, which acted as a leasing agency for operators wishing to join the program. Eighty percent of the purchase price is covered by a five-year loan at 80 percent, and the remaining 20 percent is covered by equity and a scrappage premium paid by the government in return for buying back the old minibuses. The scrapping premium is relatively high, averaging 2 million CFA francs ($3,700). The concession contracts were concluded with a number of commitments aimed at guaranteeing the quality of the concessioned service (vehicle maintenance, operation of buses on a single line, licensing, etc.). In total, this first initiative resulted in the replacement of 505 vehicles with TATA minibuses, at a cost of approximately 22 million CFA francs ($44,000) each.

Two other renewal programs then followed, financed in part by the revolving fund powered by the 8% interest paid by the operators to AFTU under the leasing agreement, as well as by EXIMBANK (Chinese import/export bank) and the Banque Régionale des Marchés. Since 2015, the program has been extended to 10 other localities in the country with 400 minibuses delivered.

The successive renewal programs have improved the quality of service for users by respecting official stops and fares, and providing more regular, reliable and comfortable services; increased transparency in management

and distribution of operating revenues; generated direct jobs (drivers, conductors, dispatchers, controllers, and route managers); and advanced training of operators in fleet management, human resources management, and financial and accounting management.

Source: CPCS (2021).

Integrated ticketing systems

Various new technologies have recently been adopted in the public transport sector (**box 7**). In the (mini)bus sector reforms, it is an important element to separate what users pay—the farebox—from the remuneration to operators for the service they render. Under the current system where bus operators have an incentive to compete for each additional passenger along the congested roads, competition in the market tends to be too intense to assure safe, reliable and comfortable services. While changing the regime toward competition for the market, it is essential to decouple the operators' incentive from fare revenues (World Bank 2021). This can be done by introducing a centralized fare collection system in the market, as deployed in many African cities (**box 8**).

In synergy with other measures, automated fare collection systems could contribute to the provision of better quality and more efficient public bus services. Automated fare collection systems will not immediately benefit Antananarivo's public transport service operations. On the operational side, however, the deployment of advanced ticketing solutions in public transport could result in increasing operating efficiency and reducing operating costs. Automatic fare collection systems are typically used to reduce dwell times in "driver only" vehicles, thus saving costs of bus conductors. Automated ticketing systems can also help to reduce potential theft or loss of revenue for operators because collected fares are recorded automatically.

Smart ticketing solutions can also allow operators to take advantage of differentiated fares, such as targeted discount and peak/off-peak fares (**figure 62**). Centralized and mandatory ticketing systems can provide near real-time information on the actual performance of each service by recording each ticket sale transaction. Over the long run, operators could use such information to manage the demand and optimize their services, for example, through reducing dwell times and allocating human resource better.

For users, there are two main benefits from the introduction of payment terminals: information and convenience benefits. The ticket provides proof of payment that consumers can use for their purposes (e.g., budget tracking, business expense tracking, etc.). The information benefit will be multiplied by the introduction of smart cards. Consumers would be able to view their transaction history, store money on the cards and better track their transportation expenses. In terms of convenience benefits, passengers could also have more flexible payment options (cash, card, point-of-sale terminal).

Figure 62. Contactless Smartcard

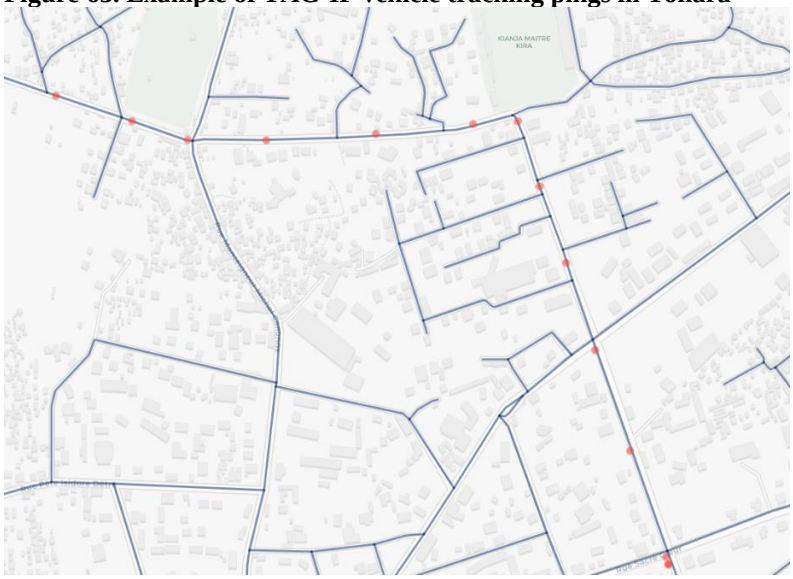
Box 7. An example of new technology that can be adopted to improve urban transport services

New technologies widen opportunities for new and better public transport services. Madagascar is not an exception. “TAG IP” is an example. It is a commercial service in Madagascar that provides vehicle tracking services for vehicle owners and operators. Their number of clients is small compared to the number of vehicles circulating in the country, and the data is not representative of all vehicles. However, Tag-IP recently won a contract with the city of Antananarivo to put their trackers on the taxi-be licensed by the city. The vehicle location data collected by TAG-IP is detailed and rich, as it tracks vehicle movements pings every twenty seconds (when operating), and reports both speed and heading (**figure 63**).

Greater, widespread adoption provides significant benefits for future transport planning in Madagascar. As the service rolls out across the taxi-be in Antananarivo, this data can provide long-term operational performance data that can inform on the state of public transport services in the broader region. This data can both be used for both real-time assessment of current conditions, and longer term planning studies (i.e. evaluation of traffic studies.

While the data can be used in one-off situations, more benefit could be derived by developing a passive data collection process and storing the data in a database with a query interface for analysts. Additional layers of automated data processing could be developed to infer items like origins and destinations, route choice of vehicles, average trip speed, average stop times, congestion, etc. to improve the management of Taxi-be services. This would require working with TAG-IP to leverage their existing systems to provide future transport analysts and planners access to it.

Figure 63. Example of TAG-IP vehicle tracking pings in Toliara



Source: CPCS (2021).

Box 8. Examples of integrated ticketing solutions in other countries

There are many prerequisites for successful introduction of integrated ticketing solutions. Notably, a strong central authority to coordinate and regulate transport services is required. However, it can provide a sustainable business case and benefits to passengers and operators. The ticketing systems are often not deployed initially to improve service efficiency but as a part of a strategy of progressive professionalization of public transport services. The ticketing systems can play an important role as:

- A data collection and monitoring tool, helping a central transport authority to keep track of the performance of operators (essential when quality contracts start to be deployed and enforced); and
- A symbol of the "unification" of transport services under a central authority.

On the African continent, similar strategies have been or are currently deployed, usually around the backbone of a BRT and/or LRT "trunk" service, in the cities of Abidjan, Lagos, Abuja, Dakar and Accra.

In Kigali, a major public transport reform was implemented in 2013 with the aim of modernizing the service offer and renewing the vehicle fleet to increase the capacity of the network. In the 2000s, the public transport offer was largely insufficient. During peak hours, it was very difficult for users to find an available seat in the vehicles that connected the neighborhoods to the city center. In 2013, the Rwandan Utilities Regulation Authority (RURA) signed four concession contracts for the operation of public transport lines in the Rwandan capital with three companies over a five-year period. In 2015, in addition, RURA issued a license to a private partner to develop a ticketing system on the public transport network. Since then, all buses have been equipped. The company that developed this system is paid by a levy on the revenues. The "smart card" is a real electronic wallet and has become the most popular means of payment.

Source: CPCS (2021).

Urban Train Project (updated)

The analysis is basically based on the current government development plan. The project consists of creating a direct link between Ankorondrano and the Gare de l'Est, passing through the Gare de Soarano, over a total length of 15.5 km. To maximize the environmental impact of the project, the authorities plan to acquire 10 self-propelled railcars that will draw their energy from a hybrid power system (JIRAMA-Solaire) for the operation of the project. The authorities expect the project to have a significant impact on improving travel times for passenger transport in general, reducing the negative environmental impact of the transport sector, and promoting public health.

The project foresees an investment of US$28.62 million on rehabilitation works and equipment and the purchase of 10 self-propelled trains for an amount of US$18.32 million at the beginning of the project. Given the current condition of the rail network, the project costs are updated. In particular, the necessary investment for the electrical installations is added because the trains are supposed to run on electricity and have already been procured (**figure 64**). This electrical installation work is estimated at US$5.72 million.

The expected demand for rail transport is also updated. The 2008 preliminary feasibility envisages an annual ridership of 1.9 million or about 5,500 passengers per day. Based on the current government operating plan (**table 12**), the demand is estimated at about 10 million passenger-trips at Year 1 (or 30,000 passengers per day), which would increase to 21 million passenger-trips by Year 30 (or 60,000 passengers per day). This is significantly different from the initial estimate.

Figure 64. Procured Self-Propelled Trains

Table 12. Assumptions for Passenger Rail Services

	2023-30	2031-42	2043-51
Number of trains	4	6	7
Number of trains in service	3	4	4
Frequency during the week	Between 15 and 18 per day	Between 18 and 20 per day	20 per day
Average annual available capacity (millions of seats)	20.6	27.5	27.5
Average annual ridership (millions of trips)	26.2	33.4	42.8
Average load factor (attendance/capacity)	53%	53%	69%

The result

With various economic costs and benefits taken into account, the financial and economic internal rate of return and the net present value of each intervention are calculated:

- Economic costs: Investment costs, such as construction costs of bus terminals and purchase costs of new buses, and operating costs
- Economic benefits: Time savings, reliability gains, amenity benefits, savings of operating costs
- Externalities: Reduction of greenhouse gas emissions, safety improvement

It is clear that that urban transport interventions focused on regulations and institutional aspects in public transport can be economically viable (**table 13**). Particularly, the proposed interventions in the bus sector are more justifiable. This is primarily because the required investment is relatively modest with focus on soft interventions, such as bus route optimization and regulatory reforms. The program focused on bus route restructuring has an estimated economic internal rate of return (EIRR) of 27 percent. By clearly delineating the two bus networks and optimizing the seat capacity utilization, a significant amount of time of passengers could be saved.

The fleet renewal is also found to be economically viable. With both components combined, the EIRR is estimated at 38 percent with a net present value of US101 million. While the program could allow to offer safer and more comfortable services, operators could also benefit from improved operational efficiency. It is better to address

both route restricting and fleet renewal at the same time.

On the other hand, the automated ticketing program may be too costly given the current circumstances in Antananarivo. It would be beneficial over the long run, generating real-time operational information and allowing operators to improve their services. But the required initial costs seem to be too high given the potentially limited use of such smartcards in the short run.

The modified Urban Train Project is marginally economically viable, but the EIRR is relatively low at 6 percent. It is critical to contain the project costs, while pursuing wider economic benefits from the project. Although the analysis already includes conventional economic externalities, such as environmental and safety benefits, there may be other types of economic benefits that are not included. For examples, additional time savings could be generated by integrating the bus and train services. Such transit oriented development may generate additional benefits, such as new business development, and allow land value capture for local governments. A sound institutional setting with good governance is needed.

Table 13. Characteristics of Current and New Buses

	(1)	(2)	(3)	(4)
Intervention	Bus route optimization	Fleet renewal	Ticketing systems	Passenger rail
Description	Optimization of taxibe and suburban bus interface, including 9 transfer terminals and 5 intersection improvements	Bus fleet renewed with larger and more fuel efficient vehicles (5,555 vehicles over 30 years)	Investing in fare terminals, establishing clearinghouse systems, and issuing smart cards	Rehabilitate the existing rail within the city, over a total length of 15.5 km and purchasing 10 self-propelled electric railcars
Investment cost ($ mil)	20.9	241.7	27.8	45.0
Operating cost ($ mil)	4.2	3.9	15.2	105.9
Daily ridership (million)				
2021	1.34	1.34	1.34	1.34
2031	1.70	1.86	1.68	1.68
2041	2.18	2.37	2.14	2.15
2051	2.78	3.03	2.74	2.74
Financial IRR (%)	0.8%	…	…	-4.3%
Net cash flow ($ mil)	-10.5	-37.5	-25.7	-46.1
Economic IRR (%)	27%	38%	10.1%	6.0%
Economic NPV ($ mil)	44.4	101.7	30.5	0.014
Cost-benefit ratio	3.18	1.90	1.15	1.00

Chapter Summary

Key takeaways from this chapter are as follows.

- To meet the rapidly increasing demand for urban mobility effectively and efficiently, a holistic approach is needed at different levels: macro, sectoral, and individual.
- At the macroeconomic and fiscal level, it is essential to strengthen infrastructure governance and be equipped with a solid, evidence-based, systematic mechanism to prioritize, select and implement public

investments. It is of particular importance to build a system to process and evaluate unsolicited proposals.

- In Madagascar, infrastructure governance looks particularly weak in the planning and allocation phases. Several important urban transport programs embarked upon by the Government are still fragmented and can be coordinated better with other complementary interventions.
- At the sectoral level, in order to improve infrastructure governance, it is important to not only prepare but actually implement a long-term urban development strategy consistently.
- In Madagascar, there is a significant implementation gap. Well-prepared urban development and transport studies exist, however, their implementation is often delayed or not realized.
- The urban transport master plan (SDT) has just been prepared in December 2021, which remains to be implemented with all relevant projects aligned.
- The proposed urban transport master plan for Antananarivo is heavily concentrated on physical infrastructure investments, including roads, railway and cable cars, which are necessary but not sufficient to support sustainable mobility in the urban sector. A more integrated approach focused on people's mobility is worth considering, using the Complete Streets and Integrated Corridor Management concepts.
- To assure the vigorous implementation of the development plans vigorously, it is of particular use to create champions for necessary institutional reforms. There are different ministries and agencies, including ATT and CUA, that are responsible for urban transport development in Madagascar. Lack of clear mandates and overlapping responsibilities among multiplicities, departments and agencies for planning, regulating, managing and financing make it difficult to address rapidly growing congestion.
- At the individual project level, it is essential to carry out rigorous project economic analysis, which allows to compare different potential options in a systematic manner and provide a guidance on how to prioritize public investments.
- The Government has recently embarked upon important urban transport projects in Antananarivo, including urban roads, cable car and urban train. It is important to verify economic, environmental and social feasibility to maximize their economic benefits.
- Bus sector restructuring is an important complementary policy to improve urban mobility in Antananarivo. Bus is the most important means of transport in GA.
- To examine priority interventions in this area, a project economic analysis is carried out to compare four types of interventions: (i) route optimization, (ii) bus fleet renewal, (iii) integrated ticketing solutions, and (iv) updated urban train project.
- Bus sector interventions focused on regulations and institutional aspects are found to be economically viable. Particularly, the bus fleet renewal program combined with bus route restructuring and development of an efficient interface between within-city taxibe and suburban buses is estimated to be highly economically viable because of both time savings for passengers and reduced operating costs (per passenger) for operators.
- The modified Urban Train Project is marginally economically viable. The rate of return is relatively low. It is critical to contain the project costs, while pursuing wider economic benefits, such as transit-oriented development and land value capture.

V. Conclusion

Madagascar has been experiencing rapid urbanization in recent years. Poverty remains persistently high particularly in rural areas. However, the number of the urban poor has been increasing rapidly, and the urban poor is more vulnerable to external shocks than the rural poor. In urban Madagascar, opportunities are not equally distributed. Transport accessibility is one of the most important constraints in urban Madagascar.

Antananarivo, the growth engine of the country, continues growing vigorously. Half of the country's urban population lives in Greater Antananarivo. However, it is shown that the people's transport mobility is most constrained in Antananarivo because of the lack of proper land use planning and the poorly regulated transport service sector. The congestion level in Antananarivo is already among the worst in the world.

The report reviewed the recent trends of urbanization and urban transport in major cities in Madagascar. It also discussed the current and future demand for urban mobility in Greater Antananarivo, exploring potential interventions to mitigate congestion and facilitate the people's mobility from the holistic point of view.

The Government has been made efforts to implement several important urban transport projects in Antananarivo, but the current policy measures are fragmented and ad hoc. The Urban Train and Cable Car Projects are important but can only improve local mobility in particular areas and cannot solve the overall problem in the city. The demand for public transport would likely be doubled by 2051. The public transport capacity based on current old, inefficient and unsafe minibuses would fall short of the expected demand by 2029.

To meet the rapidly increasing demand for urban mobility effectively and efficiently, a holistic approach is needed at different levels: macro, sectoral, and individual (**figure 65**). At the macroeconomic and fiscal level, it is of vital importance to strengthen infrastructure governance and be equipped with a solid, evidence-based, systematic mechanism to prioritize, select and implement public investments. It is important to build a systematic mechanism to process and evaluate unsolicited proposals.

At the sectoral level, it is a priority to fully implement a long-term urban development strategy consistently. It is of importance to agree on a long-term vision of urban transport development, which is elaborated by the recently proposed urban transport master plan (SDT). The plan remains to be implemented with all relevant projects aligned. In Madagascar, there is often a significant gap in implementation of development strategies. Well-prepared overall studies are often ignored. It is critical to ensure the SDT is actually implemented.

It is recommended to prepare a complementary urban mobility study more focused on people's mobility, using integrated approaches (e.g., Complete Streets, Integrated Corridor Management). The proposed urban transport master plan for Antananarivo is heavily concentrated on physical infrastructure investments, including roads, railway and cable cars, which are necessary but not sufficient to support sustainable mobility in the urban sector. A more integrated approach focused on people's mobility is worth considering.

To assure the full implementation of the development plan, it is of particular use to create champions for necessary institutional reforms. There are different ministries, agencies and municipalities, including ATT and CUA, that are responsible for urban transport development in Madagascar. It is essential to develop a well-functioning coordination mechanism or unit with clear mandates and responsibilities for planning, regulating, managing and financing urban transport development.

While creating new authorities may be seen as a long-term goal, it is useful in the short term to work within existing agencies, for example, CUA and/or ATT, to develop the necessary capacity given the time-consuming process of legally and practically establishing new authorities. The activities of the new urban transport authority should be financed by sustainable financial resources. Potential revenues in the sector, such as vehicle registration fees and license fees, can be pooled and used for its operations, but they may not be sufficient. The operating

costs must be financed by more sustainable sources, such as national budget.

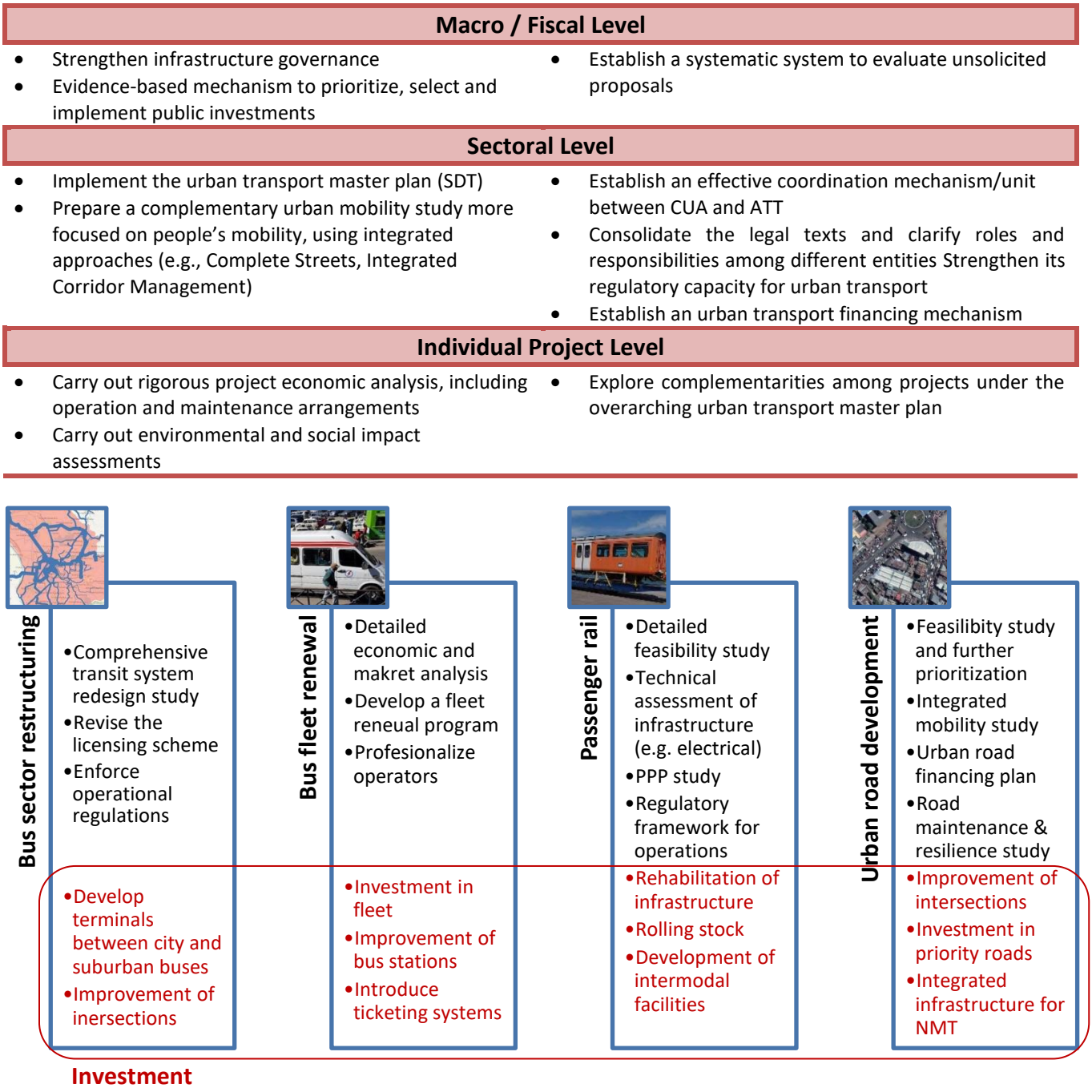
At the individual project level, it is essential to ensure that all large public infrastructure investments are evaluated by rigorous project economic analysis. Project economic analysis allows to compare different potential options in a systematic manner and provide a guidance on how to prioritize public investments. The Government has recently embarked upon important mass transit projects, such as cable car and Urban Train Projects, in Antananarivo. To ensure their technical, economic viability and sustainability, rigorous economic, environmental and social feasibility studies remain to be conducted.

Bus sector restructuring, including licensing and fare reforms, is an important complementary policy intervention to improve urban mobility in Antananarivo. Bus is the most important means of transport in GA. It is inevitable to intensify the use of public mass transit systems because the land areas dedicated to urban transport infrastructure are extremely limited in Antananarivo.

It is shown that bus sector interventions focused on regulations and institutional aspects are largely economically viable. Particularly, the bus fleet renewal program combined with bus route restructuring and development of an efficient interface between within-city taxibe and suburban buses is estimated to be highly economically viable because of both time savings for passengers and reduced operating costs (per passenger) for operators.

The modified Urban Train Project is marginally economically viable. The rate of return is relatively low. It is critical to contain the project costs, while pursuing wider economic benefits, such as transit-oriented development and land value capture.

Figure 65. Summary of Priority Institutional Reforms and Interventions in Urban Transport Sector

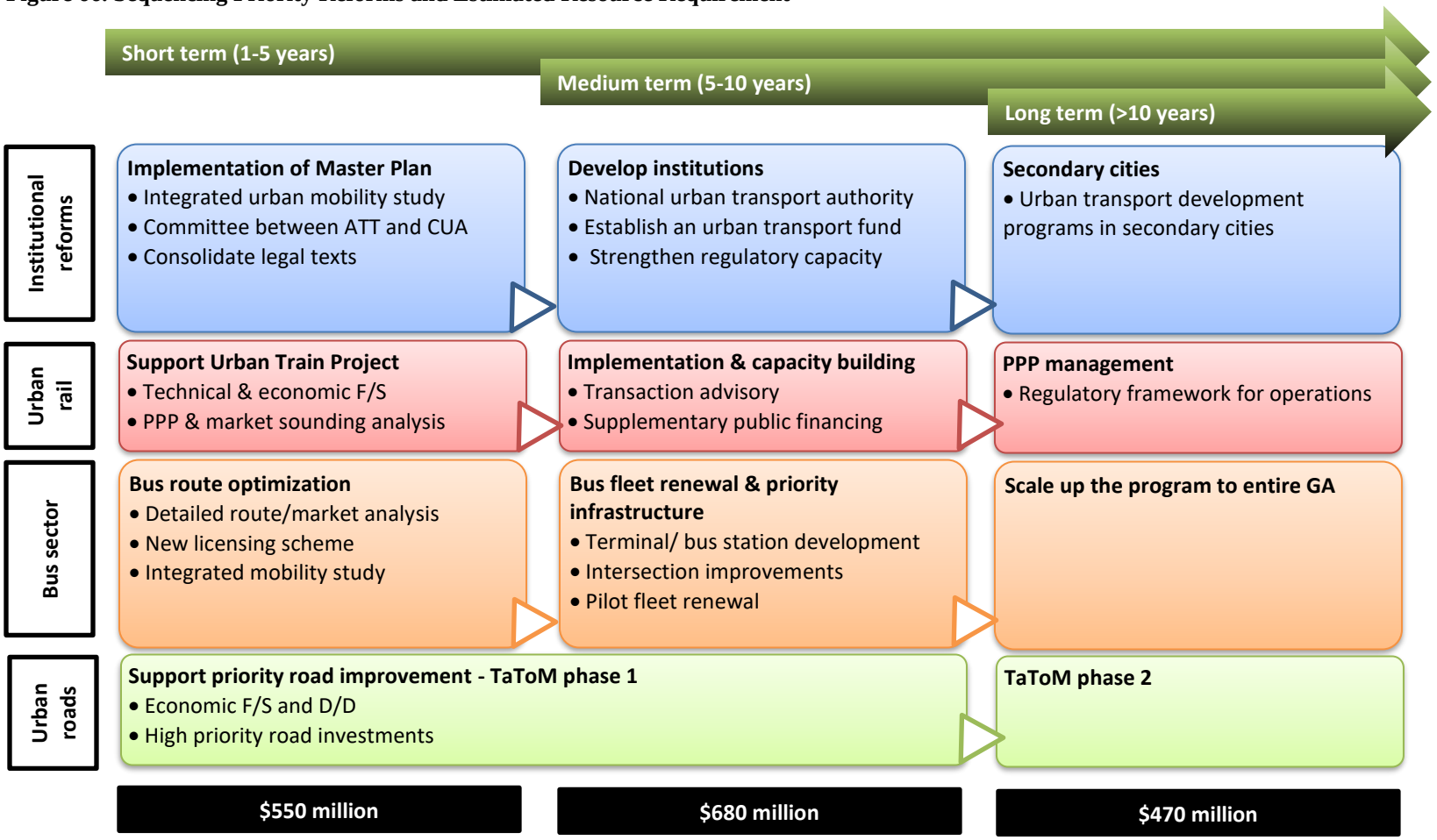


The urban transport program also needs to be implemented in a phased manner (**figure 66**). While the proposed reform agenda is ambitious, unmet financial need is also huge. Given the available information in the proposed urban transport master plan, the overall financial need for urban transport infrastructure development is estimated at US$1.7 billion for the next two decades, which includes the proposed interventions in the bus sector. The relatively short-term need is approximately estimated at US$550 million. Over the medium term, about

US$680 million would be needed. At least another US$470 million would be needed over the long term. For sustainability purposes, it is essential to establish strong infrastructure governance in the urban transport sector and develop a national urban transport funding mechanism in the long run.

Institutional reforms also take time. The gradual capacity building is essential with political support ensured. Some of the policy reforms take more than others. For instance, creating new authorities may be a long-term goal, but it is useful to work within existing agencies in the short term, supporting their capacity building. Over the medium to long term, a more integrated organization may be able to be established. While licensing reforms can be examined relatively quickly, a more comprehensive fleet renewal program may take more time. Priority reform issues in the bus sector are summarized below.

Figure 66. Sequencing Priority Reforms and Estimated Resource Requirement



Priority reform issues to advance bus sector reforms in Antananarivo

Consolidation of legal texts. The current legal texts are complex and sometimes inconsistent. Given the creation of the national urban transport authority and the adoption of the national urban transport strategy/program, the existing legal texts and regulations would need to be consolidated. To define an optimal level of supply and ensure the quality of services, the regulatory capacity needs to be built along the licensing scheme to be developed. Through the number of licenses granted, the established regulatory framework should make sure the quality of services, including safety, while improving profitability for the operators. The regulator's responsibility should be focused on:

- Controlling the quality and quantity of operators
- Supporting operators to professionalize their daily operations and collective actions (e.g., consolidation of routes, cooperatives, ticketing, and fleet renewal)
- Organizing the network through the construction of infrastructure structures
- Improving operating conditions for public transportation through traffic management measures (dedicated lanes, priority at intersections, etc.)

Bus sector regulatory reforms. At the bus sector level, the following policy reforms are critical to advance the bus route restructuring:

- Establish a coordination unit between the ATT and the CUA, responsible for the development of new bus stations;
- Create a consultation platform involving taxibe operators and authorities to clarify and facilitate the implementation of the proposed measures;
- Revise the licenses granted to the cooperatives to act on the shortening of certain lines (starting with the suburban lines);
- Strengthen field controls to enforce regulations and deter illegal operators; and
- Prepare the constitution of an urban transport organizing authority, whose mission will be to promote fare integration between urban and suburban lines.
- Conduct a comprehensive transit system redesign study, including:
    - Detailed stocktaking of supply, demand, and service performance across the network;
    - Integrated multimodal mobility plan for Greater Tana, defining the main axes of the network, the role of the different modes in the proposed transport system, and the interface poles between these models;
    - Complete overhaul plan of the line layout and the definition of a simplified and hierarchical network guaranteeing accessibility to the entire metropolitan area.
    - Regulatory frameworks to govern the supply mechanism, particularly focused on a system to grant operating licenses.

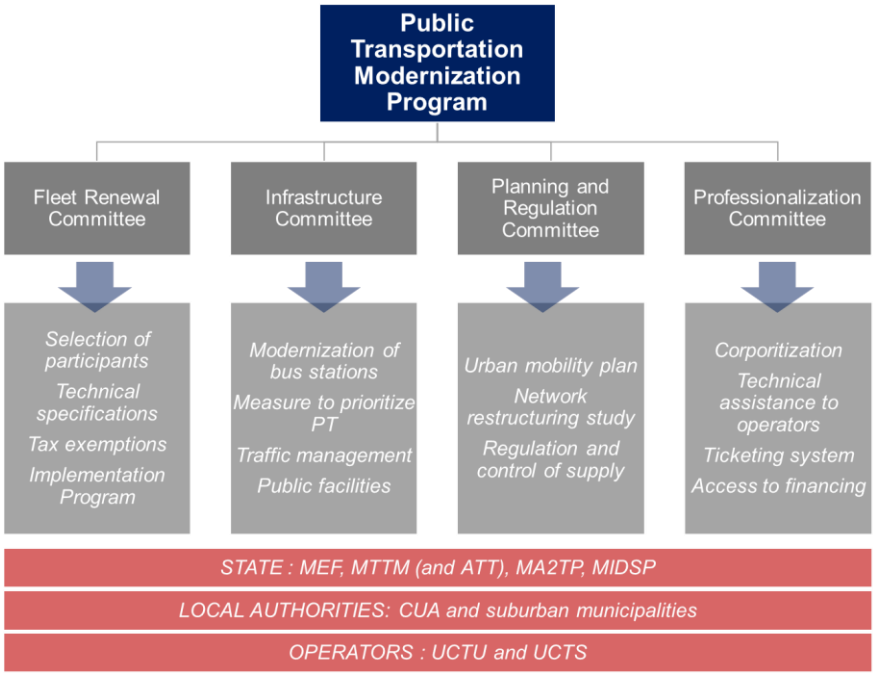
National Public Transport Modernization Program. To implement a fleet renewal program, a wide range of cross-sectoral efforts are needed (**figure 67**). With roles and responsibilities clearly confirmed, the following issues need to be addressed simultaneously:

- Carry out a detailed demand and economic analysis to design a program, including market sounding

analysis;

- Enhance planning capacity to coordinate ongoing and planned interventions across different sectors in time and space;
- Strengthen the regulatory framework to ensure the quality of service and control competition;
- Prioritize infrastructure improvements for public transportation and its users; and
- Support transport operators to be more professionalized and formalized in the renewed system.

Figure 67. Governance Structure to Implement Public Transport Program



Passenger rail reforms. In the passenger rail subsector, in theory, there are no major institutional and legal constraints that could prevent the realization of the urban train project, however, in practice there are a lot of challenges to implement the current project in an efficient but technically rigorous and politically sound manner. Particularly, no thorough feasibility study has been conducted yet for the development of this project. There is also no clear view or strategy on service provision. To advance the ongoing project, the following studies and actions are urgently required:

- Technical analysis. Carry out a technical due diligence of the existing design and feasibility study, which should include topographic, geotechnical, hydrologic, rolling stock, and design aspects;
- Social and environmental impact analysis. Detailed social and environmental assessment based on the government legal framework and international best practices;
- Financial and economic analysis. Financial and economic viability based on updated cost information from the technical analysis, social and environmental impact assessment, as well as traffic volumes stemming from a more granular market study;
- Project structuration analysis. Explore the best contractual arrangement that provides the highest value

for money for the project. Different types of PPP arrangements, including both project implementation and operation, should be compared given the current institutional setting in Madagascar.

- Operational arrangements. Based on the above, a clear operational strategy needs to be urgently confirmed and endorsed by the Government;
- Regulatory framework and capacity building. Depending on selected arrangements, the Government needs to build the adequate capacity to supervise the operations and performance of the operators.
- Transaction advisory. Hire a PPP advisor to support the government on the technical, financial and legal aspects of their negotiation with the private sector.

Appendix

Table 14. List of Major Transport Projects in Antananarivo

Project	Funding	Status of the project
Urban Train Project Project owner: MTTM Delegated project manager: MADARAIL Facilitators of expropriation procedures and beneficiaries: Commune Urbaine d'Antananarivo and the commune of Ambohimangakely	Financing planned on the 2021 Finance Act. Concession and public service delegation contract to be signed with an operator (to be identified)	• Planned: 13 electric trains already purchased by the State, of which 3 delivered to Toamasina and to be transported to Tana, and 10 still to be delivered. • Phase 1 initially planned before the end of December 2020 for a start of services in June 2021 but has experienced delays • Phase 1 will cover a 15.5 km line on the existing railroad, including 3.5 km from Ankorondrano to Soarano and 12 km from Soarano to the bypass
Cable Car Project Project owner: Malagasy State. Design and production: POMA / COLAS Consortium Objectives, strategy, organization: STCA	Financing under negotiation between the French Treasury and the Malagasy State. The planned investment is EURO 150 million.	Planned: Start of work in 2021 (no specific date)
TaToM Road Projects Management: MAHTP and MTTM Technical management: JICA	JICA	• Study already finalized in 2019 • Road projects: Ongoing and planned
Bypass (northeast and east, and Ivato Expressway) Project owner: MATP Technical and environmental: Road Authority of Madagascar Social and land: AGETIPA Expropriation and payment of compensation: HYDROTECMAD	European Investment Bank European Union French Development Agency	In progress

References

ATT. 2021. Etude du Schema Directeur du Transport dans la Ville d'Antananarivo. Agence des Transports Terrestres, Ministere des Transports et de la Meteorologie, Madagascar.

CPCS. 2021a. Madagascar: Improving Urban Transport in Greater Antananarivo: Review of bus operations and passenger rail operations, prepared for the World Bank.

———. 2021b. New Smart and Safe Mobility in Antananarivo and Other Cities, prepared for the World Bank.

Crankshaw, Owen, and Jacqueline Borel-Saladin. 2018. "Causes of Urbanization and Counter-Urbanization in Zambia: Natural Population Increase or Migration?" *Urban Studies* 56(10): 2005–2020.

IEA. 2019. GHG intensity of passenger transport modes, 2019, IEA, Paris.

Iimi, Atsushi. 2019. "Job Accessibility and Urban Transport Connectivity: Evidence from Antananarivo, Madagascar." Policy Research Working Paper 8959. World Bank, Washington, DC.

———. 2019b. "Location, Location, Location Revisited : Evidence from Antananarivo, Madagascar." Policy Research Working Paper 8958. World Bank, Washington, DC.

———. 2021. "Estimating the Demand for Informal Public Transport: Evidence from Antananarivo, Madagascar." Policy Research Working Paper forthcoming. World Bank, Washington, DC.

IMF. 2019. Public Investment Management Assessment (PIMA): Strengthening Infrastructure Governance. Fiscal Affairs, International Monetary Fund, Washington, DC.

Kumar, Ajay, Sam Zimmerman, and Fatima Arroyo-Arroyo. 2021. "Myths and Realities of 'Informal' Public Transport in Developing Countries: Approaches for Improving the Sector." SSATP Discussion Paper. Africa Transport Policy Program, Washington, D.C.

Lall, Somik, Vernon Henderson, and Anthony Venables. 2017. "Africa's Cities: Opening Doors to the World." World Bank, Washington, DC.

Ministry of Transport, Madagascar, 2004. *Plan de Developments Urbains dans l'Agglomeration d'Antananarivo*. Madagascar.

Permana, Ariva Sugandi, Gobi Krishna Sinniah, Rizon Pamardhi-Utomo, Rufia Andisetyana Putri. 2018. "Dual Formal and Informal Transport Modes towards Quasi-Seamless Transit in a Developing City." International Journal of Built Environment and Sustainability 5(3): 224-240.

UN Habitat. 2018. "World Urbanization Prospects: The 2018 Revision." UN Department of Economic and Social Affairs.

———. 2020a. "World City Report 2020: The Value of Sustainable Urbanization." UN Department of Economic and Social Affairs.

———. 2020b. Global Urban Indicators Database 2020, United Nations Human Settlement Programme.

World Bank. 2016a. "Shifting Fortunes and Enduring Poverty in Madagascar: Recent Findings." World Bank, Washington, DC.

———. 2016b. “Measuring Urban Living Standards in Antananarivo 2016.” World Bank, Washington, DC.

———. 2017. “Greater Antananarivo: Urban Poverty and Resilience Study.” World Bank, Washington, DC.

———. 2018. “Madagascar: Spatial Analysis of Transport Connectivity and Growth Potential.” World Bank Group, Washington, DC.

———. 2018b. “Pedestrian Mobility for Urban Growth: Walking and its Links to Transportation: Practical Guidance and Good Practice Examples.” World Bank Group, Washington, DC.

———. 2019. “Spatial Analysis of Antananarivo: Transport Access, Poverty and Jobs.” World Bank Group, Washington, DC.

———. 2020. “Challenges in urban mobility and the way forward: A study of Maseru, Lusaka, and Harare Cities.” World Bank Group, Washington, DC.

———. 2021. “Decarbonizing cities by improving public transport and managing land use and traffic.” Discussion Paper, Transport Decarbonization Investment, World Bank Group, Washington, DC.

———. 2021b. “Enhancing financial sustainability and commercial viability of bus rapid transits (BRTs) in Sub-Saharan Africa (SSA): The factor analysis report.” World Bank Group, Washington, DC.

Zimmerman, Sam, Said Dahdah, and Wei Wang. 2012. Integrated corridor management for urban transport. *Transport Research Record: Journal of the Transportation Research Board*, No. 2278, pp. 125-133.