Chapter 8 Public Transport Improvement Plan

8.1 Introduction

The majority of people living and working in Greater Maputo depend on public transport for their mobility and therefore public transport is a key element of the Greater Maputo Urban Transport Master Plan. However, as identified there are a number of inherent challenges and constraints with the current system that will be exacerbated as the city grows and the demand for travel increases. These principally relate to poor and inefficient network design and capacity, inadequate service levels and quality, particularly poor reliability, inadequate public transport infrastructure provision, fare level and structure issues, and inherent constraints with the institutional, regulatory, and organisational aspects of the public transport sector.

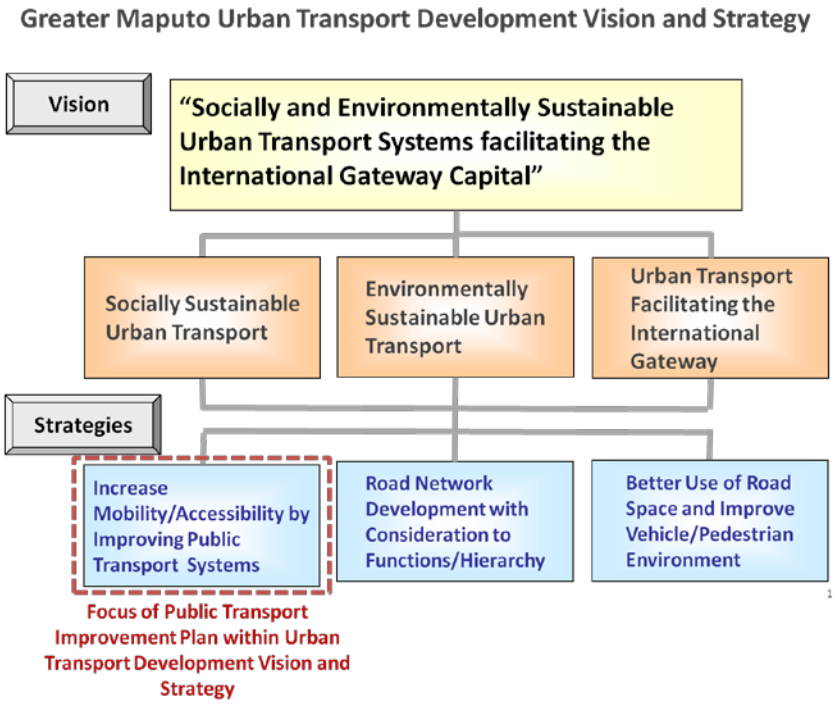
Through the Master Plan process there is a great opportunity to plan an effective and sustainable public transport system looking towards 2035, through integrated land use planning and synergies with other sectors including traffic management and highways.

This chapter sets out the public transport improvement plan including policies and strategy for development and the series of improvement projects in a phasing plan.

8.2 Policies and Strategies

8.2.1 Role of Public Transport in the Comprehensive Urban Transport Strategy

As part of the Master Plan, public transport has an important role to play in realizing the aforementioned urban development vision of Greater Maputo as a "Socially and Environmentally Sustainable International Gateway Capital" and also its three strategy components: (i) multiple core structure; (ii) sustainable economic development; and (iii) international capital for culture shown in Figure 8.1 below.



Source: JICA Project Team

Figure 8.1: Role of the Public Transport Improvement Plan within the Urban Transport Development Vision and Strategy

More specifically, the resulting Urban Transport Development Vision places public transport improvements at its core, in order to achieve **"Socially and Environmentally Sustainable Urban Transport Systems Facilitating the International Gateway Capital"**. Public transport will be vital in delivering the associated three Greater Maputo Urban Transport Master Plan strategy components:

- Socially sustainable urban transport
- Environmentally sustainable urban transport
- Urban transport facilitating the international gateway

Increasing mobility and accessibility by improving public transport will be central to delivering these components.

As set out in Chapter 5, the public transport improvement plan must provide the following main outputs:

- Modal shift from private car to public transport
- Fewer private cars on the road leading to reduced traffic congestion
- Resulting socio-environmental benefits including reduced pollution, transport costs, and travel time, as well as increased accessibility
- A sustainable and integrated public transport system

8.2.2 Public Transport Development Strategies

Chapter 5 set out the public transport development strategies that will help deliver the Urban Transport Development Vision and achieve the outputs described above. These strategies include the following:

(1) Introduce Mass Transit Systems (e.g., commuter rail, LRT, BRT)

Introduce high quality mass transit (e.g., commuter rail, LRT, BRT) integrated with the wider sustainable public transport system to address Greater Maputo's current and future needs.

(2) Integrate Transport and Land Use Planning (Transit Orientated Development)

Transport and land use planning should be fully integrated to yield the maximum benefits for the public transport system as well as environmental and social benefits. To this end, the mass transit system should be supported by Transit Oriented Development (TOD), with a concept example shown in Figure 8.2 and further discussion in Technical Report P.

(3) Make Public Transport More Convenient, Faster, More Comfortable, Cleaner, and Safer for All Users

Provide efficient, convenient, accessible, comfortable, clean, and safe public transport for all users including vulnerable groups, e.g., children, the elderly, and the disabled.

(4) Improve Public Transport Infrastructure

Improve public transport infrastructure including formal, properly designed and located terminals, intermodal facilities, designated and well-located bus stops, bus priority measures lanes, and depot and workshop facilities. In addition, ensure that the public transport network is supported by walking and cycling links to stops and stations and central areas, smooth interchanges (transfers), taxi service, and clear and integrated public transport information, marketing, and ticketing.

(5) Ensure Use of Appropriately Specified Vehicles

Ensure use of appropriately specified vehicles for each type of service, including providing additional buses to appropriate specifications and improving the availability of the Transportes Públicos de Maputo (TPM) fleet so that it will make a substantial contribution to the improved public transport services proposed in the Urban Transport Master Plan.

(6) Develop and Enforce Appropriate Regulations, and Formalize Public Transport Industry Structure

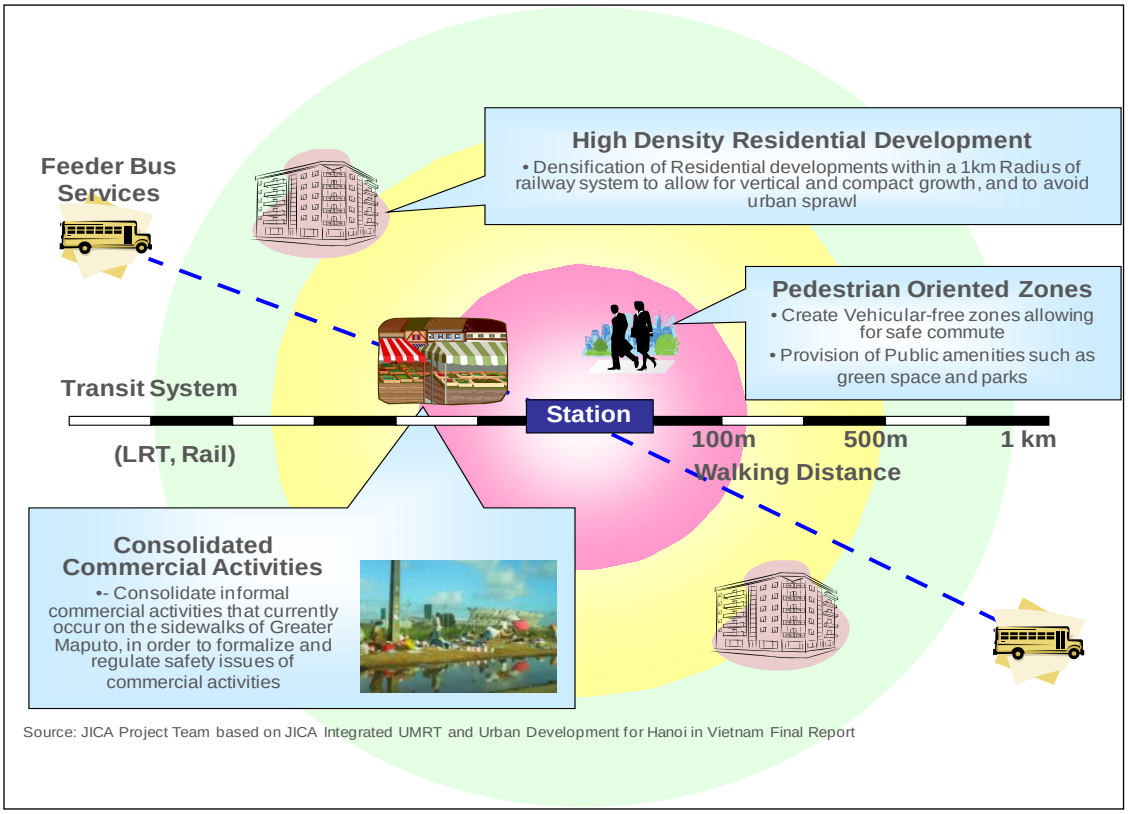
Develop and enforce appropriate regulations, and formalize the public transport industry structure. The current inefficient and heavily constrained informal public transport sector should be transformed to a formalised public transport industry, and their roles gradually changed to feeder mode to the proposed mass transit systems.

(7) Implement a Financially Sustainable Fare Structure

Implement a financially sustainable fare structure including careful consideration of fare structure, fare scale, fare levels, and implications for collection and ticketing.

(8) Improve Institutional Capacity

Improve institutional capacity to ensure that all agencies and institutions, in both the public and private sectors, responsible for the provision of public transport services, have adequate resources. Such resources include the number of appropriately qualified personnel, effective systems and procedures, equipment, and funding, to secure the provision of a public transport system that will meet future needs of Greater Maputo.



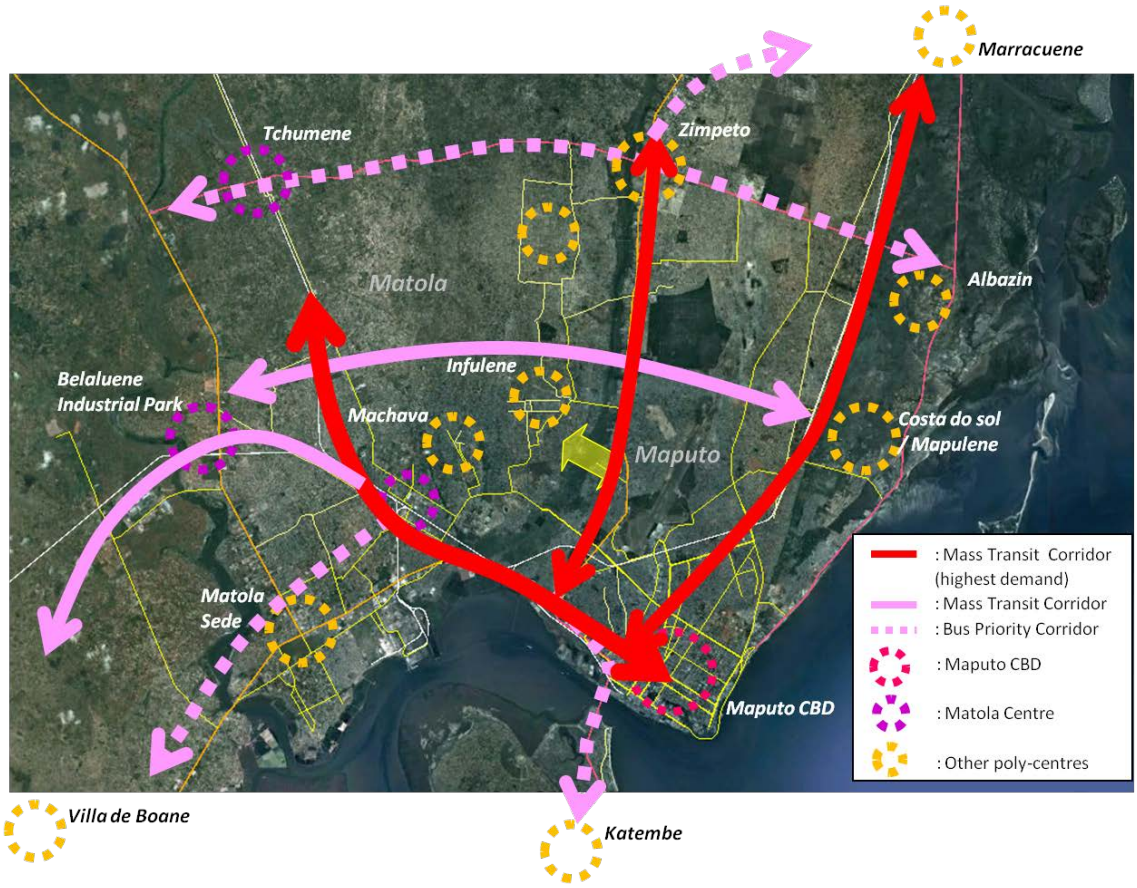
Source: JICA Project Team

Figure 8.2: Concept of Transit Oriented Development in Public Transport Planning

8.3 Key Mass Transit Corridors and Proposed Systems

To achieve the urban transport development vision and realize the above strategies for public transport, a step change in provision is required through implementation of a comprehensive and integrated public transport network including mass transit provision. To this end a wide range of options are available.

Based on the future demand analysis, desire line patterns for public transport trips were analyzed in order to identify the key mass transit corridors. Desire lines are the corridors with the highest forecasted demand. As already set out in this report, the desire lines resulted from extensive surveys (including HIS) and modelling. From this, the key mass transport corridors were set out and are shown in Figure 8.3.



Source: JICA Project Team

Figure 8.3: Key Mass Transit Corridors for Greater Maputo

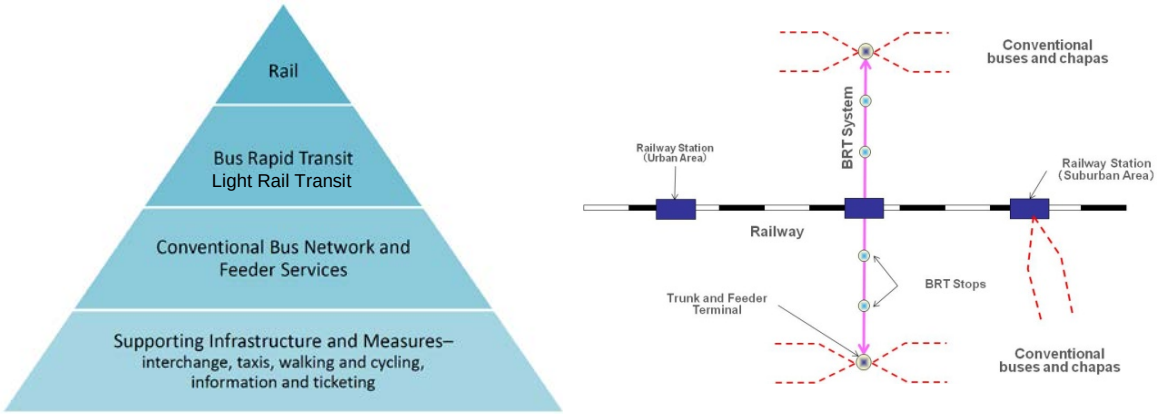
Table 8.1 shows key characteristics of major mass transit systems. Based on the estimated demand and cost performance as well as potential for taking advantage of land availability, heavy rail and BRT systems are selected as main public transport systems for Greater Maputo.

Table 8.1: Mass Transit Systems

Item	Heavy Rail	LRT[1]	BRT
Maximum Speed (km/h)	90–100	60	60
Capacity (passengers/unit)	1920[2]	160	160
Line Capacity (pphpd)	28,800 (frequency, every 4 minutes)	1,800 (frequency, every 5 minutes)	10,000 (frequency, every 1 minute) for a single lane 7 m busway
Typical Construction Cost	High	Medium (In some cases, similar to Heavy Rail)	Low
Application to Greater Maputo	Possible to construct existing rail right of way	Require new right of way or structure and can be expensive	Possible to construct with available road space

Note 1: Type of LRT in Hiroshima, Japan was considered; Note 2: 10 cars per train
Source: JICA Project Team

The mass transit network forms part of the Master Plan's integrated public transport network. The development of this public transport system considers how different modes contribute different parts of the public transport offering to meet Greater Maputo's needs. This is best represented as a public transport hierarchy (see Figure 8.4) which provides the steps to development of the complete, integrated public transport system. As outlined in this chapter the proposed public transport hierarchy for Greater Maputo include commuter rail for the highest demand corridors and longest journeys, supported by BRT and then the conventional bus network and finally walking and cycling for the shortest journeys. The following sections outline the proposals for each.



Source: JICA Project Team

Figure 8.4: Greater Maputo Public Transport Hierarchy

8.4 Rail

8.4.1 Role of Passenger Rail in Greater Maputo

A full-fledged passenger railway can transport passengers in a congested urban area from one point to another in the largest number and in the shortest time in comparison with other modes of transport such as private vehicles, *chapas*, and buses, and even BRT. This is particularly true during peak periods when a large number of workers commute between their home and workplace, consequently creating traffic congestion. Passenger rail trains can carry a large number of passengers at a high speed, undisturbed by traffic congestion.

Due to a rail system's ability to attract a large number of trip makers along a fixed corridor, land use along the corridor often becomes denser (particularly at nodes). Land use becomes more

concentrated along the corridor. This Transit Oriented Development (TOD) is in line with the public transport policies already outlined and therefore is a key component in making rail a successful component of the integrated public transport system.

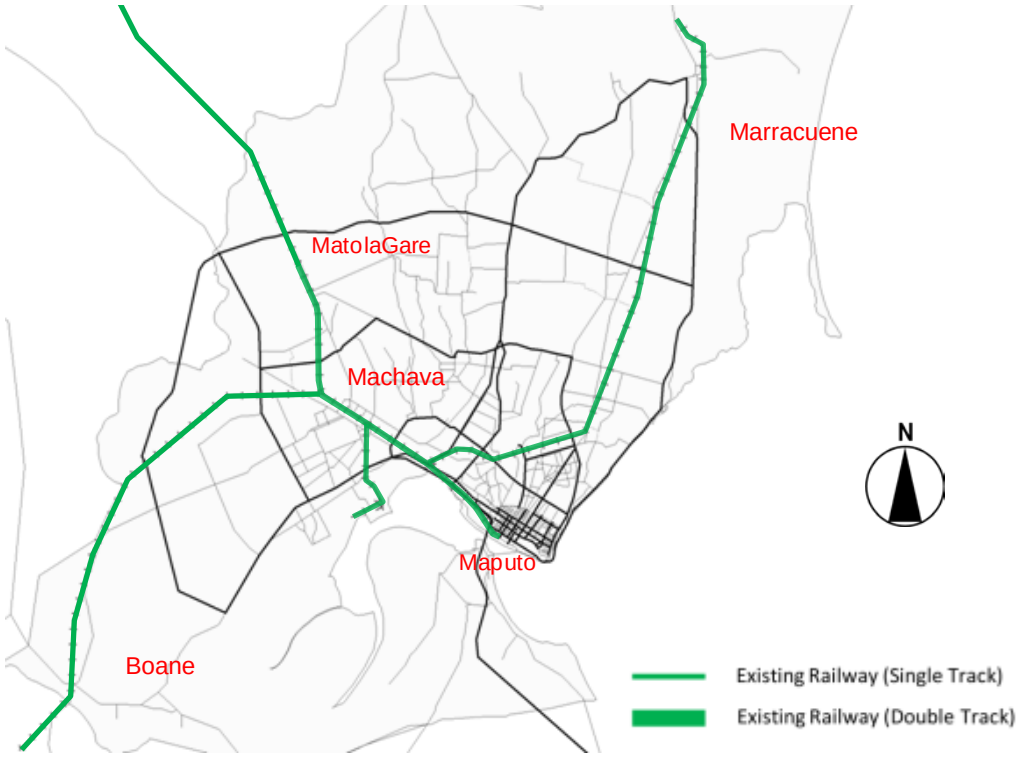
Construction of railways can be expensive, particularly to secure necessary right-of-way in already densely populated urban areas. In Greater Maputo, however, the public sector already possesses sufficient land along the existing railway lines. These lines are also located along corridors with sufficient potential railway users and an influx of residents once such a passenger services are in place is expected.

When development sites have improved access to other parts of the metropolitan area through the delivery of the passenger rail system, land prices and property values will increase from competition to locate activities along the corridor. Railways are expensive to build, but if increases in property values can be captured and pay for the cost, at least in part, the overall cost to the provider can be much lower. This practice of "value capture" is most prominent in Japan. Technical Report P illustrates cases in Japan and shows the framework of introducing such system in Greater Maputo.

8.4.2 Existing Railway System in Greater Maputo

All railways in Mozambique are owned by Mozambique Ports and Railways (CFM), which is under the Ministry of Transport and Communication. CFM used to be a national organization but has been a public corporation since 1995. It is divided into four regional corporations: CFM South, CFM Central, CFM North, and CFM Zambezi. Railways in Greater Maputo are under CFM South.

Existing railway routes are shown in Figure 8.5. The portion between Maputo and Matola Gare is double track and the rest is single track.



Source: JICA Project Team

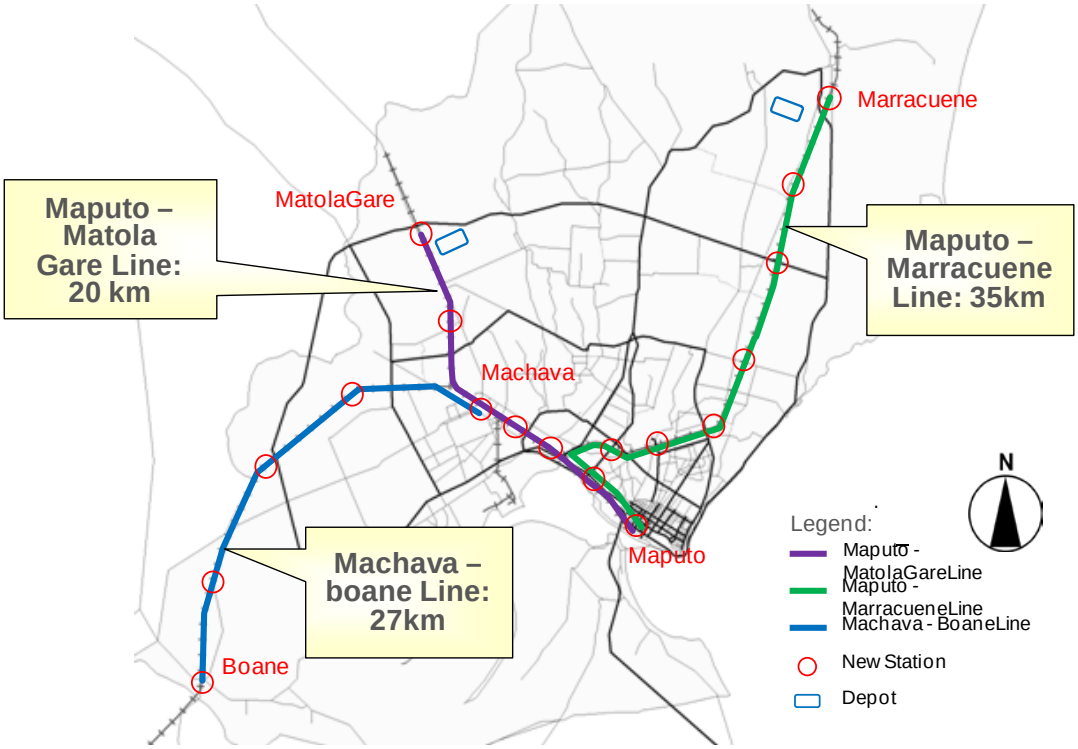
Figure 8.5: Existing Railway Routes in Greater Maputo

CFM holds the right-of-way along the rail track for 50 m on both sides of the outermost rails. However, there are many illegal dwellings within the right-of-way. CFM's main operation is for freight transport. Goods unloaded at Maputo Port adjacent to Maputo Station are transported by railways to various parts of the country and beyond and goods originating in Mozambique and neighboring countries are also transported by railways to Maputo Port. A few passenger trains are run.

The largest number of trains in the Maputo metropolitan area is found in the Machava–Matola Gare section; 21 trains in one direction are operated daily from 5 am to 10 pm, of which 16 are freight trains and 5 are passenger trains. There is about one train every hour.

8.4.3 Proposed Passenger Rail System

After surveying the existing situation of railway services in Greater Maputo, the following three lines for the new passenger rail services (shown in Figure 8.6) are proposed, in order to minimize cost and to take maximum advantage of changes in the land use pattern.



Source: JICA Project Team

Figure 8.6: Passenger Rail Network

- *Maputo–Matola Gare Line*: The line length is 20 km. Existing right-of-way is to be utilized. Strong population growth is forecast along this corridor.
- *Maputo–Marracuene Line*: The line length is 35 km. Existing right-of-way is to be utilized. Public transport for the northeast part of Greater Maputo is to be served. Areas in Marracuene are currently thinly populated and the future development potential of the area is high.
- *Machava–Boane Line*: The line length is 27 km. Existing right-of-way is to be utilized. Public transport for the southern corridor is to be served. Passengers transfer at the Machava Station to Maputo–Matola Gare Line. While population growth along this line is less than the above two lines, the development potential is very high.

8.4.4 Design Passenger Volumes

Outline daily passenger volumes in 2035 have been estimated using the previously described JICA System for Traffic Demand Analysis (STRADA) model. The maximum hourly volumes have been taken as 20% of the daily volumes.

(1) Maputo–Matola Gare Line

Daily passenger volume: 332,000 (both direction)
Maximum design one direction hourly volume: 33,200

(2) Maputo–Marracuene Line

Daily passenger volume: 237,000 (both direction)
Maximum design one direction hourly volume: 23,700

(3) Machava–Boane Line

Daily passenger volume: 271,000 (one direction)
Maximum design one direction hourly volume: 27,100

8.4.5 Railway Equipment and Facilities

Passenger rail cars driven by electricity should be considered. Diesel is not considered in this study as the daily volume is estimated at relatively large level of 300,000.

The necessary number of rail cars is shown below, based on the following assumptions: (i) maximum number of passengers per car of 200; (ii) average speed of 50 kph (urban) and 60 kph (suburban); and (iii) headways of 4 minutes (urban) and 10 minutes (suburban):

- Maputo–Matola Gare Line: 10 cars × 15 trains = 150 cars
- Maputo–Marracuene Line: 10 cars × 20 trains = 200 cars
- Machava–Boane Line: 10 cars × 10 trains + 10 cars × 5 trains = 150 cars
- Total: 500 cars

The following three plans are considered for track construction. The merit (advantage) of each plan and necessary conditions for implementation are described below:

Option A: Feature: Current trains and new passenger trains will share the same tracks (Figure 8.7)

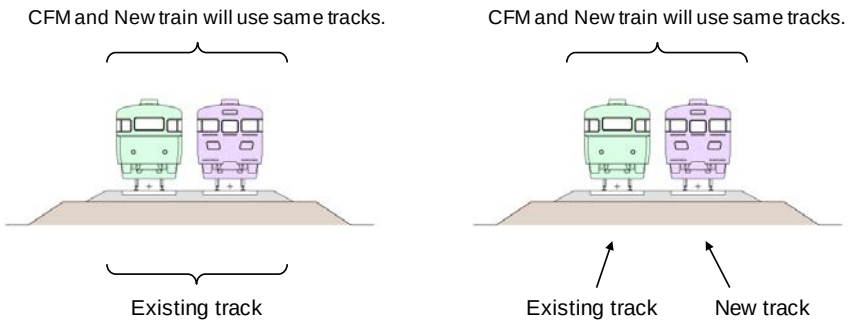
Merit: The cost of civil construction work is minimal.

Measure 1: All trains must be equipped with an automatic train stop (ATS) system (include similar) and current trains must be kept punctual in their schedule.

Measure 2: Current trains must be limited to night time operation for the sections to be served by the new trains.

Note: Measures 1 and 2 are independent of each other.

Length of tracks newly constructed: 47 km (single track)



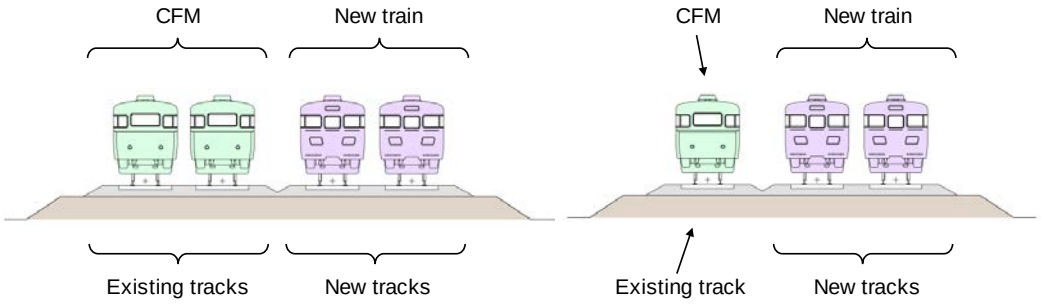
Source: JICA Project Team

Figure 8.7: Option A for Track Construction

Option B: Feature: New double track lines for the new services will be constructed, leaving the existing CFM services intact (Figure 8.8).

Merit: The effect on the existing CFM services is minimal.

Length of new track construction: 134 km (single track equivalent)



Source: JICA Project Team

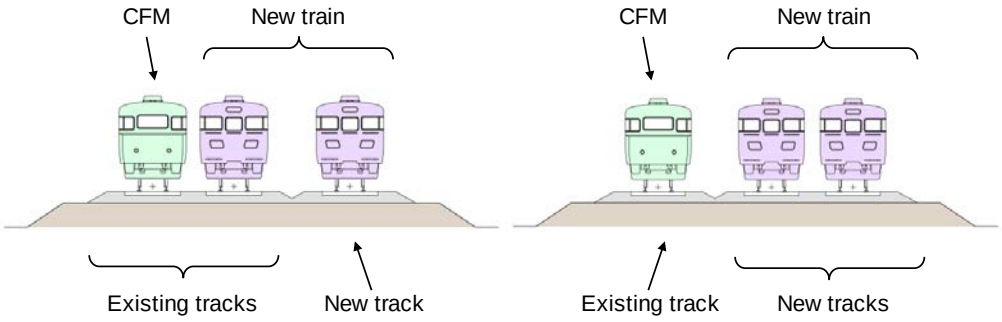
Figure 8.8: Option B for Track Construction

Option B-1: Feature: Current trains will use single track and new tracks will be constructed where necessary to provide double track for the new passenger services (Figure 8.9).

Merit: This option is less costly than Option B as only a single track is to be constructed within the existing double track portion.

Measure: Rescheduling of existing CFM services.

Length of new track construction: 114 km (single track equivalent)



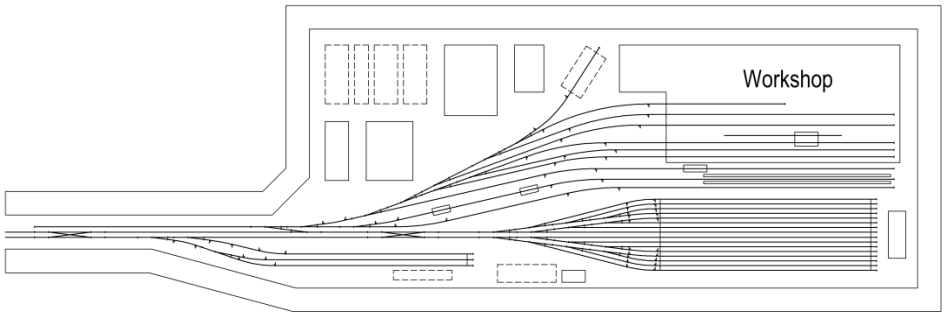
Source: JICA Project Team

Figure 8.9: Option B-1 for Track Construction

When long-distance trains and commuter trains utilize the same track, delays in the schedule of the long-distance trains directly affect the operation of commuter trains. Plan B is recommended since the freight volume handled by CFM is expected to grow substantially as the economy of Mozambique grows. The construction cost can be lowered with Option B-1 only if CFM can operate its services on a single track.

A new long bridge will be needed at the intersection with road N4 as an overpass. Having freight trains detour is another option.

Train depot(s) (Figure 8.10) and a workshop will be constructed. One depot for the whole network is desirable. If not possible, multiple locations for depots may be necessary. The depot(s) will require 15–20 ha.



Source: JICA Project Team

Figure 8.10: Concept of a Depot

Train safety systems (e.g., ATS systems, train communication systems) are essential since headways of the order of 10 minutes are envisaged. It is desirable to establish a train control centre that centrally controls train operations over the entire network.

Grade separation is necessary at crossings with high road traffic volumes. In principle, current all grade-separated crossings will continue for the new lines.

8.5 Bus Rapid Transit (BRT)

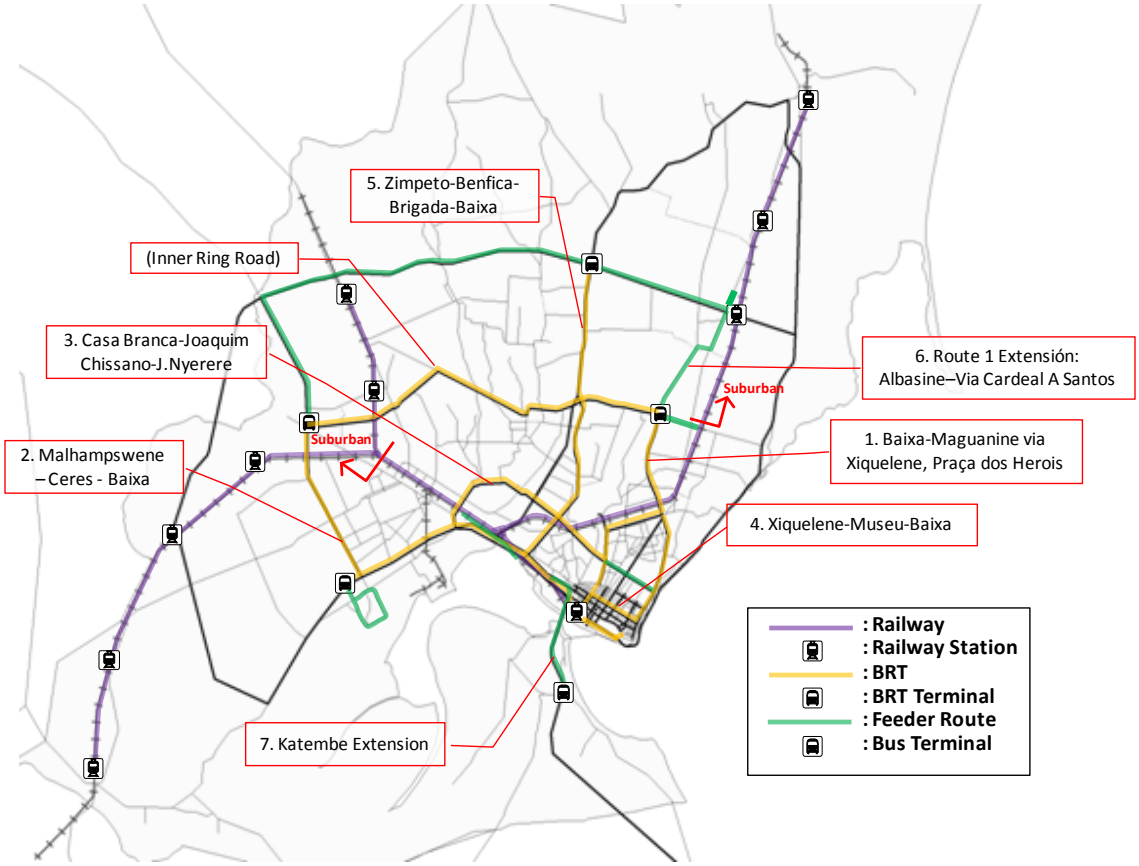
8.5.1 Proposed BRT System

As identified in the proposed public transport hierarchy, BRT has an important role to play in supporting the key rail corridors and providing the complete mass transit network required for Greater Maputo. The proposed BRT system is therefore a major component of the Master Plan and its components are introduced in the following sections.

This form of low-cost mass transit has proved to be pivotal in many countries, aiding cities in moving away from the model of public company bus transport, with its associated problems (e.g., overstaffing, underfunding, problems with spare parts), and away from a poorly regulated private sector based on second hand minibuses. This Master Plan and other studies in progress by the municipality, as well as experience elsewhere, indicate that high-capacity BRT has an important role to play in the development of Greater Maputo.

8.5.2 BRT Network for 2035

Figure 8.11 presents the network structure of the proposed BRT system in 2035.



Source: JICA Project Team

Figure 8.11: Proposed BRT Network in 2035

Table 8.2 summarizes the BRT routes, complementary inter-district routes, and infrastructure. These complementary routes use will conventional units that link the main terminals without any special or additional infrastructure, such as bus ways.

Table 8.2: Proposed BRT Routes for 2035

No.	Route	Route Characteristics	Length (km)
1	Baixa–Maguanine via Xiquelene, Praça dos Herois	Covers the high demand section between Maguanine/Xiquelene/Praça dos Herois and the Baixa. A busway 'spur' on Eduardo Mondlane will also offer services to the Museu area	12.9
2	Malhampswene–Ceres–Baixa	Important inter-municipal BRT Route that could be incorporated into the development plans of Katembe Bridge and the upgrading of the Toll Road. Essential for the success of all TDM as it offers a premium alternative to the high car usage between Matola and Maputo	21.2
3	Casa Branca–Joaquim Chissano–J. Nyerere	Covers the high demand section between Machava and Xiquelene. Operational studies will determine how this will access the main Machava demands	13
4	Xiquelene–Museu–Baixa	Extension of the Museu spur route that can offer an alternative to the highly congested Vladimir Lenine Binary for passenger demand coming from Xiquelene	10

No.	Route	Route Characteristics	Length (km)
5	Zimpeto–Benfica–Brigada–Baixa	The N1 corridor can be transformed into a fully urban Avenue with BRT standard transport. This route is essential to alleviate congestion and performs an important social role. The construction of the new 'Green' line highway would offer an alternative for through traffic	16.2
6	Route 1 Extensión: Albasine–Via Cardeal A Santos	When the feeder demands at the end of a BRT route become too high, BRT routes are normally extended by the addition of a new terminal and busway track. This option thus offers a better service at a lower cost for passengers.	6
7	Katembe Extension	During the first decades of urban expansion following the opening of the bridge, it will not be possible to serve all the residential zones with bus services, thus a simplified form of BRT – with priority on the bridge and access roads – and integrated into the full BRT system will be needed. This will have feeder bus and park and ride facilities.	11.8

Source: JICA Project Team

8.5.3 Modelled Demand

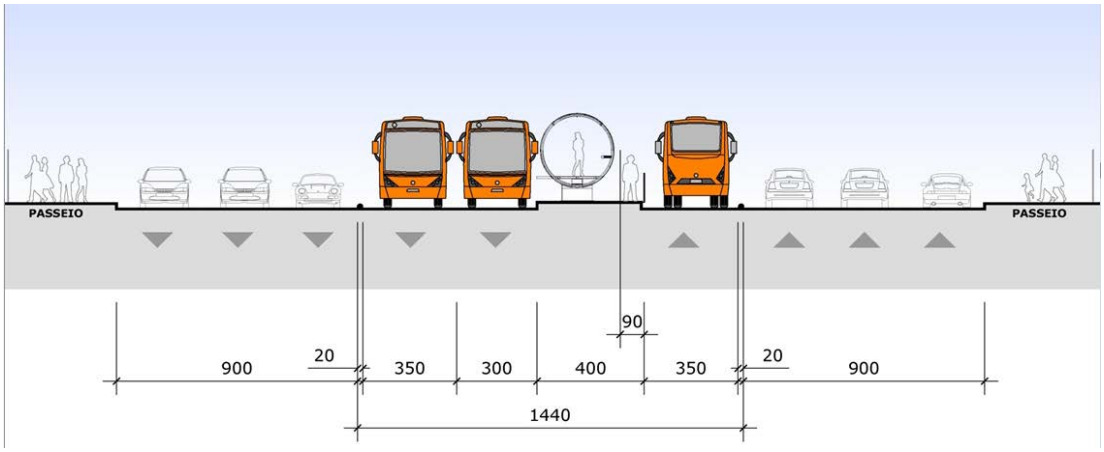
The results of passenger demand analysis for the year 2035 indicates that for the Phase 1 corridors, which includes the section between Maguanine/Xiquelene/Praça dos Herois and the Baixa, and the link from the N1 corridor to Baixa, the maximum daily demand per direction is around 100,000 passengers per day, or for a peak hour factor of 20% (as used for the rail proposals) this would be some 20,000 in both directions.

This level of demand is fairly constant for both the Xiquelene–Centre section along Av. Acordos de Lusaka and for the N1 section between downtown and Benfica. The downtown demand is evenly split between the Baixa and Museu Terminal areas.

The maximum capacity limit of 10,000 passengers/h/direction is for single lane BRT, so the designs on these heavily loaded sections should accommodate overtaking for direct services. In this case, demands of up to 30,000 have been handled.

8.5.4 Specification of the BRT Corridors

The design of the most heavily used BRT routes should thus incorporate overtaking at stations, which implies a design width of 38 m for traffic with 3 lanes and including a sidewalk of 2.5 m on each side. A diagram of a typical cross-section with a busway flanked by the traffic lanes is shown in Figure 8.12.



Source: JICA Project Team

Figure 8.12: Typical Cross Section of Station Area with Overtaking Lane and Three Urban Traffic Lanes

For Phase 1, most of the road width on the corridors is constrained to 30 m with a 5 m median (Forças Populares de Libertação) or a 3 m median (Acordos de Lusaka), although this latter road has a lateral drainage channel that would allow for extra road width.

On the N1 corridor it is suggested that, until the Green Highway is completed, stops should only occur at special integration stations which are set every 1,000 m. This minimizes pedestrian risk and the need for increased road width.

On the constrained stretch between Avenidas Marien Ngouabi and Eduardo Mondlane it will not be possible to allow overtaking or stations, as the 20 m in width only allows for a 7 m busway, two 5 m traffic lanes, and a footpath of 1.5 m.

The Phase 1 pilot project is 12.5 km in length, with a 2.9 km 'spur' to the Museu and uses technology that has been tested under similar conditions in Brazil and South Africa in terms of climate and passenger behavior.

In summary, some of the typical key specifications for the BRT system include the following examples:

- The busway is projected to be in reinforced concrete with an adequate road base, although the exact specification will depend on each stretch.
- These lanes will be separated from other traffic by studs in resin that allow the bus units to exit the lanes while avoiding encroachment of the busways by other traffic.
- The roadways will have basic landscaping and tree planting as part of general urban improvements.
- Ideally, stations should be set at every 400–500 m, with sliding doors for at-floor bus access, etc.
- The expected number of stations is about 30, including 25 stations that offer access to busways in both directions, and stations that, for reasons of width, only provide access to one direction of busway. At the Baixa there will be full integration with the main rail station.
- Central access stations are now generally adopted as they require less road width and are cheaper to install, operate, and maintain. Dimensions vary, but a minimum width of 3 m is often used.

- Fares will be collected from smartcards with readers at the stations. Initially integration will be within the BRT system, covering the main routes and all feeder and inter district routes. Eventually, the cards could also be used for rail travel.
- Intelligent Transport System (ITS) measures will include green light priority for BRT (with extension and early cutoff for other stages). Pedestrians will also use signals where appropriate so as to allow for special-needs access. The system will have a control centre and standard GPS unit control.
- Pedestrian access to the station areas will be improved along the corridor 250 m on each side of the stations and on both sides of the corridor .
- Extensive feeder bus route improvements will be considered, e.g., improved stops, paving.
- As well as the main terminal facilities at Maguanine and Baixa, the system will have a basic BRT depot that will be completed and operated by the concession holder, and integration platforms and works at Praça dos Herois and Xiquelene.
- Most of the road widening and resettlement will be concentrated in the stretch between Xiquelene and Maguanine, while drainage works will be concentrated in the section on Acordos de Lusaka.

8.5.5 Phased Development of BRT

(1) Phase 1 – 2018

The proposed first phase covers the high demand section between Maguanine/Xiquelene/Praça dos Herois and the Baixa. This test case will determine how effectively the concession is working, how construction compares with expected costs and timeframes, how the BRT route interacts with other modes, and how the private *chapa* operators react to the necessary changes in regulation and operations.

Phase 1 also considers extending the BRT services to the important N1 corridor to the Baixa area. This could be achieved by building a specific new corridor to the Brigada (or Joachim Chissano), or a lower-cost option would be to connect the major residential zones along the N1 to the pilot scheme busway on Av. Acordos de Lusaka.

(2) Phase 2 – 2025

It is envisaged that the second phase will include the main Matola–Maputo links, with two new options: one via Museu and the other on the widened Joaquim Chissano Highway. This phase will either involve a solution for inserting a busway on the existing toll road or adding a new link as part of the overall access to Katembe Bridge. Each BRT route will depend on one or more integration terminals that will receive the associated feeder routes.

At this stage, inter-district routes would also be introduced, linking the BRT corridors (and eventually the upgraded rail services) without the need for passengers to change units in the downtown areas. These would also be controlled (or operated) by the BRT concession holders.

It is envisaged that at least two inter-district routes would be needed to complete the network: as part of Phase 2 the first inter-route would be introduced passing through the denser inner suburbs. No special infrastructure is required other than a reasonable pavement surface.

(3) Phase 3 – 2035

The extension of the first route to Albasine could be achieved through the extension of the BRT corridor along the Julius Nyerere Highway or by using the wide right-of-way of the Cardeal Alexandre dos Santos Road to incorporate a central lane BRT busway.

This phase would see an extension of the BRT system to Katembe via the new bridge. The design of the infrastructure of the actual bridge and approach roads will depend on the degrees of congestion experienced. A reversible (tidal) flow BRT/HOV [high occupancy vehicle] lane, for example, could provide the necessary transit preference.

The second inter-district route, following the Ring Road and serving the newer developments, could then be incorporated into the system.

(4) Feeder Services

The network development described above must include feeder routes. These are the conventional routes that distribute the demand from the BRT terminals to the suburbs and are an integral part of the BRT concession and can be operated either as:

a) Subcontracted units that offer a connection from the residential zones to the main BRT terminals, or
b) Units operated by the same BRT companies that hold the concessions.

In both cases, strict control of access to the terminal facilities is required, in other words, these components of infrastructure will have to be built by, or under the control of, the operating companies.

The exact routing of the feeder routes will depend on the demand at the time of contract, the quality and availability of access roads and the capacity of the terminals; however, the usual catchment zones for a BRT terminal are of the order of 5 km.

The only terminals that are likely to operate feeder services that are beyond these limits are those at the outskirts and with other metropolitan towns not yet served (e.g., Matola, with routes to Boane). There is a great risk, however, of succumbing to the political temptation of offering integrated fares to areas that are economically outside the natural catchment zones, thus increasing overall system costs, with consequent effect on fares.

To avoid this risk, it is common for non-integrated and semiformal feeder services to operate as separate transit links with non-integrated fares. The design of the major terminals should consider this form of service as extremely likely and provide access and loading/unloading facilities.

8.6 Conventional Bus Services

8.6.1 Introduction

The third tier of the proposed public transport network hierarchy (after mass transit rail and BRT) is the role of conventional bus services, which will be vital in ensuring an effective network and accessibility of the wider area. The route network for the conventional bus system will, in turn, depend on the nature of the high-capacity mode network (rail and BRT). It is possible to design a route network for the complementary bus services when the networks for these other modes are finalized in detail.

However, the flexibility of the conventional bus as an urban transport mode will enable the services to be adapted to complement the BRT or rail services as they develop; it is therefore necessary only to make recommendations regarding: i) the immediate bus route network requirements; and importantly ii) to ensure that the bus industry in Greater Maputo has the capability and resources to adapt as necessary.

The route network should be redesigned based on a set of basic principles including, but not limited to, the following:

- The redesigned route network should strike a balance between the aim to maximize passenger convenience by providing direct links between origin and destination for the majority of passengers, and optimizing vehicle utilization.
- Whilst in some cases it will be necessary for passengers to interchange during their journeys, it is desirable to minimize the number of interchanges to be made by passengers.
- Although the current practice of arbitrary route cutting by *chapa* drivers is deplorable, it is rational to vary the service frequency on different sections of a route to match variations in demand. Typically, the demand for a bus route increases as it approaches the central area. The frequency can be varied, or tapered, accordingly by scheduling some buses to operate over only part of the route; on long routes it may be necessary to provide terminal facilities at several intermediate points where buses may turn short.
- It is also generally desirable to minimize the need for bus terminal facilities in the city centre area. Terminals require large areas of land, which in city centres is scarce and expensive. Often the only space available is inconveniently located, so that passengers must walk further to and from their destinations, and buses may lose time in accessing and leaving the terminal; such movements frequently add to traffic congestion. It is therefore recommended that wherever possible, bus routes should extend beyond the central area, and in many cases should operate from one outer suburb to another, via the central area.

8.6.2 Recommended Projects to Improve Conventional Bus Services

(1) Restructuring of the Public Transport Industry

The principal options regarding the structure of the public transport industry in Greater Maputo have been considered in detail in Technical Report F ranging from a no change scenario to the various roles of private and public sectors, role of TPM in the short, medium and long term and the role of FEMATRO and the associations. The recommended restructuring of the public transport industry is set out below, alongside the appreciation that the transition from the present to the proposed industry structure will take time and must be managed carefully and sensitively step by step over a 10 year period.

The objective of this project is to ensure that the public transport industry is capable of delivering the services planned by Greater Maputo Metropolitan Transport Agency (GMMTA) to meet the travel requirements of the residents of Greater Maputo in an efficient, safe, and cost-effective manner, in accordance with the standards specified by the authority.

The proposed GMMTA will mainly be a recommendatory and coordination body with some exceptions and all modes and aspects of transport including public transport the Greater Maputo Metropolitan Area will be addressed by the agency. The aim is to ensure effective implementation and coordination of the various transport and traffic measures undertaken by relevant agencies in the Greater Maputo Metropolitan Area. Full details are described in later chapters, however GMMTA responsibilities will include the integration and regulation of the

operation of buses and *chapas* operated within the metropolitan area; and the integration of various routes of public transport and issues of combined ticketing, feeder services etc.

The project will manage the transition from the existing informal industry structure, comprising a large number of individual owners in addition to the publicly owned TPM, to one comprising a small number (up to 20) professionally managed public transport operators, each operating at least one bus route in its entirety. All bus services will operate in accordance with schedules planned by GMMTA, which will award route licences to the formal operators through a competitive bidding process. The operators will be governed by the same rules as TPM and will compete on an equal basis (eventually, TPM may be transferred to the private sector). The existing small *chapas* will be phased out, and replaced by a smaller number of larger-sized conventional buses. [1]

Several thousand people depend on *chapas* for their livelihoods, and the restructuring process must be managed carefully and sensitively, for example, with the following considerations:

- Despite its shortcomings, the *chapa* industry, including the operators' associations, represents a significant resource in terms of expertise and capability which should not be wasted. As part of the transition process, it is desirable that the *chapa* operators who wish to remain in the business should be given the opportunity to adapt to the more formal operating environment.
- The *chapa* owners are encouraged to combine to form larger entities such as cooperatives or companies. These entities should invest in a smaller number of buses with approved specifications, and would eventually be eligible to apply for licences to operate formal bus services.
- The *chapa* drivers are encouraged to be employed by these larger entities or seek other transport-related job opportunities to minimize the extent of unemployment.
- While the enforcement of rules and regulations governing the operation of public transport services should also be strengthened, this must be carefully phased and should not be implemented too quickly.
- The industry restructuring process requires cooperation and assistance of the operators' associations. The associations need to be persuaded to convince their members that the proposed changes are necessary and inevitable, and that it is in their interest to adapt. The associations must endeavour to ensure that as many as possible of their members who so wish are redeployed within the new formal system. They must also assist in identifying alternative livelihoods for those who are displaced.
- Many of the senior officers of the associations are transport operators, and some may be eligible to formalise and develop their own business as part of the reform process: they should be encouraged to do so. Employees and appointees of the associations who currently perform regulatory and enforcement roles may have potential for retraining for equivalent roles within the formal sector and this should be implemented wherever possible, with the assistance of the associations.

The timeframe of the project will be about five years, which will enable most existing *chapas* to operate to the ends of their economic lives. However, if progress is slower than expected (e.g., if informal operators are reluctant to accept change and a prolonged period of negotiation is

[1] Using the transport model outputs obtained in this study, the total number of trips by public transport in 2035 (for Scenario C transport network) is estimated to be about 2.1 times the trips made by chapa and bus in 2012. Even excluding the trips by BRT and commuter rail, the number of trips by public transport in 2035 is estimated at about 80% of the trips currently made by chapa and bus. These estimates indicate that there is significant room for many of those currently in the chapa business to continue to engage in the public transport sector in the future.

required, or simply because progress is being made slowly) up to ten years should be allowed for completion. This longer time frame should be achievable.

Individual demand-responsive services (taxis and txopelas) would continue to operate informally but the GMMTA would control the numbers (to prevent excess capacity) and quality. Fares should be consistent and charged by meters fitted in all vehicles.

The local government agencies and enforcement agencies, and the GMMTA when it is established, will have key roles to play in the process. This project should be coordinated with the Capacity Building for the Bus Sector project.

The key tasks will be:

- Implement measures to ensure that no new licences are issued for *chapas* to operate within Greater Maputo, and to ensure that no *chapa* is operated without a valid licence; licences will not be issued for replacements for *chapas* that are taken out of service; advise *chapa* owners that any remaining licences will not be renewed at the end of the five-year implementation period.
- Ensure that vehicle safety inspection requirements applicable to *chapas* are rigidly enforced; this must be phased, with required standards raised progressively over the five-year period. Vehicles failing to comply during routine inspections will have their licences revoked unless all defects are rectified.
- Establish a training program for displaced *chapa* drivers and other employees of the *chapa* industry to retrain as bus drivers, conductors, or mechanics.
- Arrange training courses in principles of bus operation for potential private sector bus operators.
- Arrange seminars on the setting up and managing of cooperatives and small businesses for *chapa* operators.
- Provide credit facilities to *chapa* operators to purchase new buses to approved specifications (similar to those to be purchased for TPM) provided that they dispose of their *chapas*, and maintain and operate the buses in accordance with GMMTA requirements.
- Develop bidding procedures for route licenses.
- Initiate bidding process.
- Establish depot and workshop facilities for use by private sector bus (and temporarily by *chapa*) operators (to be developed under the Bus System Infrastructure Development project).

Although ideally the implementation agency should be the proposed GMMTA, it is desirable that the project commence as soon as possible and therefore the Maputo Municipal Council (MMC) should be responsible for start up of the project, with the GMMTA assuming responsibility when it becomes operational. Ideally, the MMC officers responsible for the project start-up should be transferred to GMMTA.

(2) Capacity Building for the Bus Sector

The objectives of this project are to ensure that all agencies and institutions, in both the public and private sectors, responsible for the provision of public transport services in Greater Maputo, have adequate resources to secure the provision of a public transport system that will meet the future requirements of the conurbation effectively, economically and safely to internationally

acceptable standards. Such resources include the number of appropriately qualified personnel, effective systems and procedures, equipment, and funding.

The project will include an assessment of capacity deficiencies, and development of measures to address these, including recruiting and training of personnel, and recommending measures to address other resource deficiencies. In addition, experts will be assigned to key institutions to work alongside existing officers, to assist in key functions where there are known deficiencies, and to provide on-the-job training at the same time. The project will:

- Develop capability within the departments responsible for public transport within local government, and later within the proposed GMMTA, to plan public transport routes and services within Greater Maputo, and secure their delivery by suitable operators, to monitor their performance and to ensure that all services are operated in accordance with specified standards
- Develop capability within TPM (and the two municipal companies being created through the reorganization of TPM) to operate urban bus services efficiently to international standards, including effective fleet maintenance, supervision of scheduled services, staff discipline, general management, and proper financial control of the businesses
- Develop capability within private sector bus operators (and existing *chapa* operators willing to formalize their businesses) to operate urban bus services efficiently to international standards, including effective fleet maintenance, supervision of scheduled services, staff discipline, general management, and proper financial control of the businesses
- Develop capability within the relevant enforcement agencies to ensure compliance by public transport operators with all applicable regulations, and ensure compliance by all other road users of traffic regulations that facilitate the operation of public transport services
- Improve performance in areas where there are known weaknesses such as vehicle maintenance (TPM and private sector) and public transport planning (local government/GMMTA)

The key tasks will be:

- Identify, in conjunction with the relevant institutions, existing and projected (10 years) human resource requirements and deficiencies (e.g., adequacy of organization structures, posts to be filled, number of staff required and their qualifications)
- Assess training requirements for existing personnel and additional personnel required
- Identify equipment requirements (and deficiencies) necessary for all functions to be performed effectively (e.g., office equipment, vehicles, tools etc) at present and in the future (10 years)
- Identify problems arising from shortages of materials and consumables (e.g., office supplies, spare parts)
- Identify funding constraints
- *(the above tasks are to be performed within TPM and its successors, local governments[Maputo, Matola, Marracuene, and Boane) and the GMMTA when formed, as well as within the municipal and traffic police)*
- Develop appropriate training programs including training for private sector bus operators once these become established; this should include secondment for selected

personnel (up to 6) to an overseas transport operator/regulatory agency (preferably in Portugal)

- Provision of expert assistance and on-the-job training in:
  - Bus service planning and scheduling (1 expert at MMC/GMMTA, alternating with TPM)
  - Bus service procurement and regulation (1 expert at MMC/GMMTA)
  - Bus service monitoring and supervision (1 expert at MMC/GMMTA)
  - Bus maintenance (2 experts at TPM)
  - Management information (1 expert at TPM)
  - Enforcement (1 expert, shared among agencies)
- Secondment to overseas transport operators/regulatory agencies

While ideally the implementation agency should be the proposed GMMTA, it is desirable that the project commence as soon as possible and therefore MMC should be responsible for the start-up of the project, with GMMTA assuming responsibility when it becomes operational. Ideally, the MMC officers responsible for the project startup should be transferred to GMMTA.

(3) Bus Network Design

Based on the overarching principles for the design of the future bus network, this project would prepare a bus network design on a micro level, based on emerging requirements. This project will aims at developing an effective feeder routes for rail and BRT systems as well as to cover areas where mass transit routes would not be able to serve effectively.

The project will require examination of travel patterns of all existing and potential public transport users. This will be followed by identification of alternative route network options (e.g., trunk and feeder, convergent routes) to identify the most appropriate option(s), and develop the network for the short term. Proposed new public transport modes, such as BRT and rail, must be taken into account, and the bus network designed as part of a fully coordinated system. In addition, the scope for different levels of service quality (e.g., basic and premium, with different fare levels) will be assessed and included in the network plan if appropriate. The exercise will include calculation of the capacity required for each route, the optimal bus type for each, number of buses required, and service frequency. It will also be necessary to develop a phased plan for the implementation of the network and associated bus fleet changes.

The key tasks will be:

- Bus passenger demand patterns
- Assessment of route network and service options
- Development of optimal route network for the short term
- Assessment of likely changes to the route network in the medium term
- Calculation of capacity requirements for the short and medium term
- Determination of bus types and numbers required for the short and medium term
- Development of a phased implementation program for the short and medium term

(4) Bus Fleet Renewal

This project is to ensure that sufficient conventional buses, to an appropriate specification for operation on urban services in Maputo, are available to meet the requirements of the route network to be developed under the Bus Network Design project.

The project is intended primarily as a short-term measure to increase the capacity of the public transport system in Maputo and to progressively replace the small *chapas* with larger vehicles

that are more suitable for the purpose. At present, TPM is the only operator with the infrastructure to service and maintain a fleet of buses (although additional resources will be required) and therefore it is recommended that all new buses under this project should be allocated to TPM or its successors. In the longer term, measures to improve the capability of the public transport sector, under other projects recommended by the Master Plan, will ensure that the industry is sustainable and capable of funding additional and replacement buses. Also, in the medium term, new urban transport modes such as BRT or rail may be introduced, so that the total requirement for conventional buses may be reduced. This project, therefore, is not intended to provide sufficient conventional buses to meet all future public transport requirements, but to address the present service capacity shortage, and to enable the worst of the *chapas* to be replaced within a short time scale. The project includes the refurbishment of unserviceable TPM buses, as well as the procurement of new buses to an appropriate specification. In any case, it is impractical to acquire a very large number of buses simultaneously, since the capability to operate and maintain them will take time to develop, while there are good operational reasons for having an even fleet age profile, with a similar number of buses requiring replacement each year.

The key tasks will be:

- Determine appropriate specifications for buses for urban services in Greater Maputo, and identify potential manufacturers
- Obtain quotations from suitable manufacturers/suppliers, and place orders for new buses
- Implement measures to limit the introduction of additional *chapas* to urban services in Greater Maputo (MMC)
- Strengthen enforcement of roadworthiness regulations applicable to *chapas* to eliminate the worst vehicles from the system, and prevent the operation of illegal public transport vehicles (National Land Transport Institute, INATTER[2]/MMC)
- Assess unserviceable TPM buses, and identify those for which there is economic justification for refurbishing – this will determine the number of new buses to be acquired
- Establish resources required (e.g., spare parts, labor) and the cost of refurbishing unserviceable buses
- Develop and implement program for refurbishing unserviceable buses
- Develop and implement effective preventive maintenance program to ensure future fleet availability and reliability
- Determine staff requirements for refurbishment program and continuing preventive maintenance program, and recruit as necessary
- Recruit sufficient drivers and conductors to operate all serviceable buses

TPM is in the process of being reorganized and divided into two separate companies owned by the Maputo and Matola Municipalities, respectively; at present, it is still operating as a single entity, and it is recommended that the refurbishment project be undertaken at the TPM depot in Maputo, although subsequently some refurbished buses may be operated by the Matola company. The new buses should be shared between the two companies. Since the Maputo depot belongs to the Maputo company, it is recommended that MMC be responsible for the implementation of this project. This project should be coordinated with the bus maintenance components of the technical assistance project.

[2] Instituto Nacional dos Transportes Terrestres.

8.7 Public Transport Fare Levels

8.7.1 Major Issues

The level of public transport fares in Greater Maputo is an important and sensitive issue which must be appropriately addressed. Major issues on the public transport fares are described below (see Technical Report F: Public Transport Improvement for more details).

(1) Fare Levels and Affordability

Although there have been periodic increases in fares, these have not fully compensated for the cost increases that have been experienced in recent years. Transport operators consider the fares to be low, while some users feel that they are excessive.

However, the fares charged are clearly affordable by the majority of travellers since the services are well patronised, with a shortage of capacity at peak times. No doubt there are potential passengers who are unable to afford the existing fares, who would travel if fares were lower. This will always be the case, but when funds are limited a line must be drawn somewhere.

Key factors regarding the fare levels include the following:

- Due to the practice of "route-cutting" by *chapas* (i.e., cutting routes into short sections), which forces passengers to transfer to another vehicle and pay an additional fare (or several additional fares), many are paying more than the fares intended by the authorities. While passengers may resent this, they are nevertheless paying, and are able to do so. This should be recognised.
- It must also be remembered that the quality of the present service is low; this can and must be improved, but the extent to which it is improved will affect the cost, and a balance must therefore be found.

(2) Frequency of Fare Adjustments

Approval for operators to increase fares is given infrequently; the last three approvals were in 2004, 2008 and 2012, i.e. at four-year intervals. As a result, when increases are authorised, the extent of the increase is necessarily substantial, which comes as a shock to people whose incomes are low. If fares had been permitted to increase more frequently but by smaller increments, the effect would have been less noticeable and controversial.

(3) Cost Recovery and Subsidy

According to bus and *chapa* operators, current fare levels are inadequate to cover the full cost of providing the services. TPM receives a subsidy to make good its losses[3] while private sector operators are compensated with a subsidy on diesel fuel, but this is inadequate to cover the full shortfall between costs and revenue. Many *chapa* owners have gone bankrupt or left the industry as a result of poor financial performance.

Although the official government policy in Mozambique is that public transport services should be operated commercially, without subsidy, a general understanding is that services should be provided at "social" fares. As the level of TPM operation is expanded significantly at the current fares, not only will many higher-income passengers benefit unnecessarily, but the requirement for subsidy will increase substantially. Government must decide whether this is acceptable; if not, the increase in TPM's operation, while desirable, would not be financially sustainable.

[3] TPM's operating subsidy is currently equivalent to approximately 50% of its total expenditure.

8.7.2 Recommendations

It is recommended that the fare policies for public transport in Greater Maputo should take into account the following:

- Public transport fares in Greater Maputo should be regulated by government, and fare scales and structures must be consistent throughout the whole of Greater Maputo.
- Public transport fares should be reviewed at least once per year and adjusted as necessary on a regular basis to ensure that all increases in the cost of inputs are fully compensated for.
- Public transport services should not be subsidised unless government requires certain services to be operated at fares which do not fully cover their costs. If government requires certain classes of passengers to travel at reduced concessionary fares, operators should be reimbursed for the resulting revenue shortfall.
- Fares charged by TPM are generally lower than those charged by *chapa* operators, but this social benefit is not available to everybody, due to TPM's limited services. Considering the financial condition of TPM and the high level of government subsidy currently provided, TPM fares should be increased at least to the same levels as the *chapa* fares. If this is not possible for all TPM buses, the higher fares should be charged on all new TPM buses introduced from now on in order to reflect the underlying costs in the fare level.
- For the planned BRT services, it is reasonable to set fares higher than those for conventional TPM buses, reflecting the underlying costs and considering that the level of willingness to pay for the BRT services would be higher than that for conventional buses since BRT is expected to provide superior or premium public transport services. This tendency is clearly indicated by the mode choice model estimated based on the stated preference survey conducted in this study. In the case that the BRT fare is higher than that for conventional buses by 10MT, it is estimated that more than 70% of bus users are willing to use BRT rather than conventional buses even though the travel time is the same for both services. (For more details of the stated preference survey conducted in this study, see Technical Report K: Transport and Traffic Surveys: Methodology and Analysis.)
- The existing flat/coarse fare scale of TPM[4] that involves the issue of cross-subsidisation should be replaced by a graduated scale, related to distance travelled. A zonal fare system, with a flat fare within each zone and a higher fare for zone crossing trips, would meet this requirement. This should be studied in the recommended bus network design initiative.
- As the bus system in Greater Maputo develops and becomes more organised, more sophisticated ticketing/fare collection systems may be introduced, thereby achieving good revenue security and enabling more complex fare structures to be implemented.
- Regarding the ticketing/fare collection systems, in general terms, the more effective the system, the greater its complexity, and the more expensive it is to install and maintain. A balance must be found between a simple, inexpensive manual system and a more user-friendly, secure system. As technology improves, however, more sophisticated systems are becoming more affordable, and for the long term it is desirable that a ticketing system is developed to meet the specific requirements of the Greater Maputo system.
- In a multimodal public transport system, it is desirable for tickets to be useable for all sectors of a trip, including the use of different routes and different modes; it is inconvenient if separate tickets must be purchased for each sector of a trip. An electronic stored-value "smart-card" system, available on all modes throughout the network, regardless of operator, is becoming common in large cities, and such a system will be appropriate for Maputo in the long term.

[4] TPM applies a flat fare of MT 7 on most of its routes, with higher flat fares on some longer routes and express services.

8.8 Supporting Infrastructure and Measures

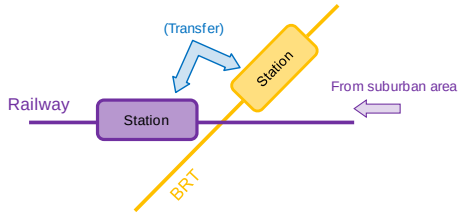
8.8.1 Stations, Stops, and Intermodal Hubs

(1) Intermodal Hubs

While reducing the need to interchange (transfer) is a key factor in the effective planning of the public transport and land use networks, there will still be the need for interchanges, particularly at key hubs in between modes. At present, many change *chapas* to reach final destinations. Mass transit must be designed to allow for convenient transfers to other mode. The following are basic principles for designing intermodal facilities.

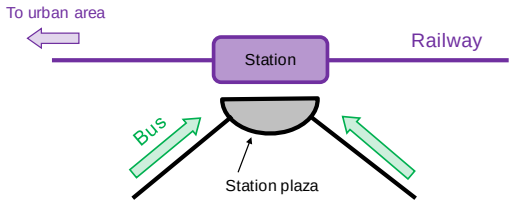
Stations in the urban area should be designed to provide for easy transfers to the BRT network (see Figure 8.13). Better connectivity to other public transport modes will result in higher efficiency of the urban transport system as a whole. For that purpose, stations should be located near intersections with the BRT network and station entrance/exit gates should be placed near the BRT station.

The primary concern for suburban stations is transfers to/from the bus/*chapa* network (see Figure 8.14). Buses/*chapas* collect passengers in surrounding residential areas and deliver them to the station. Stations therefore should be located at places where access roads are secured. A bus terminal plaza should be prepared at each station to make transfers easy. Taxi ranks located at these interchange also help maximise integration and accessibility.



Source: JICA Project Team

Figure 8.13: Intermodal Facility in Urban Area



Source: JICA Project Team

Figure 8.14: Intermodal Facility in Suburban Area

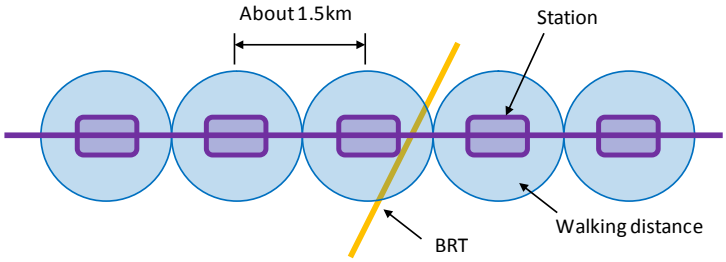
These hubs offer new travel options in order to capture potential public transport demand. This infrastructure is normally called an Integration Terminal or Interchange and should be located in relation to the present transport demand as well as the planned development structure of the city.

These allow passengers in the city centre to take the first arriving trunk unit without waiting for a specific route number, which reduces waiting times and queues. The waiting/station areas needed on the central area trunk sections are therefore relatively small.

(2) Rail Stations

The roles of passenger railway stations are different in central/urbanized areas and in suburban areas. The basic principles for locating stations are described below.

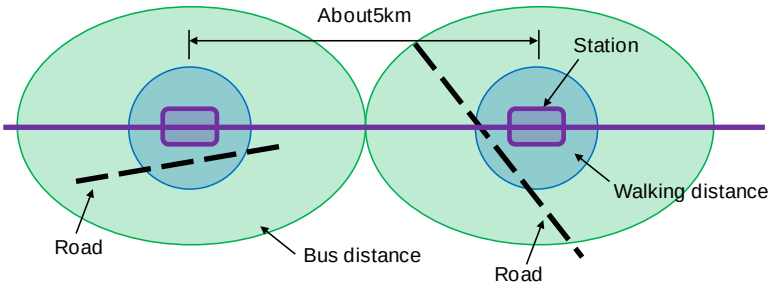
Central/Urbanized Areas: Stations in central/urbanized areas are direct access points for neighboring business and commercial facilities and also function as transfer points for other public transport modes. Stations in these areas are therefore placed at intervals of about 1.5 km and at junctions with other public transport modes (Figure 8.15).



Source: JICA Project Team

Figure 8.15: Station Location in Central/Urbanized Areas

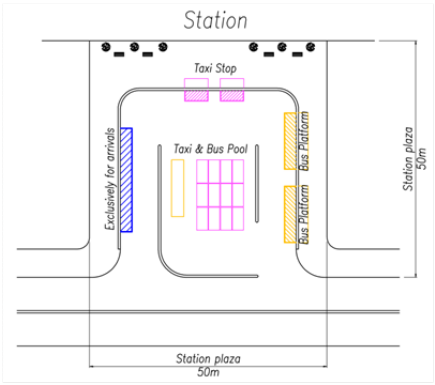
Suburban Areas: Stations in suburban areas are primarily points from where commuters in the surrounding residential areas are transported to the urban centre. Residents of surrounding areas reach the station on foot (or by *chapa* at present). Therefore, stations are placed at intervals of about 5 km and at locations where access roads can be secured (Figure 8.16).



Source: JICA Project Team

Figure 8.16: Station Location in Suburban Areas

Station and Station Plazas: At-grade stations are considered to minimize costs. Footpath overpassses for passengers to cross tracks would be included. In suburban areas, station plazas (providing bus services in front of the station) would be developed to facilitate intermodal transfers (Figure 8.17).



Source: JICA Project Team

Figure 8.17: Concept of Station Plazas

(3) BRT Terminals/Interchanges

Building an interchange allows bus services to be segmented into trunk routes, feeder routes and inter-district routes, offering new travel options and thus capturing the "repressed" public transport demand which does not use the bus as the route network does not comply to the passenger's needs.

Integrated Terminals serve as the primary tool for rationalizing the entire bus system in a way that allows for the provision of transport to be quickly and accurately adjusted to the real demand in each part of the bus network. The frequency and regularity of bus services on each of the routes that serve Integrated Terminals maybe increased considerably in many cases, particularly within urban centres where there is the greatest concentration of riders.

The consolidation of centre-bound trips at Integrated Terminals can significantly improve the flow of buses in the central area, while reducing the inconveniences often associated with boarding, alighting, and waiting for buses.

Through optimising the use of the bus vehicles, both in terms of capacity and efficient scheduling, the overall costs of providing transport can be reduced, and likewise the total capital investment required in fleet.

Finally, the concentration and consolidation of passenger activity at Integrated Terminals encourages the consolidation of commercial sub-centres at these locations.

From these hubs, passengers can choose from various route options:

- **Trunk Routes:** The trunk routes in an Integrated Urban Transport System share several common characteristics: They operate at high frequencies (normally less than 6 minutes) along the main transport corridors of the city, linking the city centre with major Integration Terminals. They also feature enhanced ITS traffic signalling, geometric and/or bus priority measures, and stations set at intervals compatible with increased operating speeds.
- **Feeder Routes:** Most of the bus routes that serve (or "feed" into) the Integration Terminals are formed by conventional routes on the outskirts of the city or system. Once at the terminal, the feeder route passengers are offered access to the entire Integrated Urban Transport System, including the variety of trunk lines described above as well as all of the other feeder lines that converge there – without having to pay another fare. Feeder routes use conventional buses at intervals selected to both minimize passenger waiting times and passenger crowding.
- **Inter-District Routes:** These routes link the major BRT corridors, allowing passengers to transfer from one corridor to another without having to pass through the city centre.

The proposed BRT Integrated system will be formed by linking the following major integration hubs:

Table 8.3: BRT Terminal Recommendations

Terminals	Terminal Characteristics
Estação CFM	Main integration area for all suburban rail and the BRT routes coming from Matola, Katembe and the North
Maguanine	First major terminal for feeder units and starting point of the First Trunk Route
Xiquelene Adaptation	The existing bus station will need to be adapted to serve as a 'through' terminal with a design that minimizes the loss of time of the main trunk BRT routes. Access for all units as well as feeder units and passengers will also need to be reviewed.
Praça dos Herois	It is expected that there will be pressure to integrate services from Av. Moçambique to the BRT routes that will require facilities to be incorporated into the initial designs. Provision for this should be made in the initial phasing.
Matola	As well as receiving the feeder routes from Matola, this terminal will also serve Boane and will be dimensioned as such
Jamo	This terminal is essential to structure the N4 urban corridor and will serve the new areas in the immediate region, as well as the commercial installations along the corridor
Matola City	Already an important *chapa* terminal as well as suburban train station, this terminal offers integration between all services, especially the Inter Terminal services envisaged that will link the main corridors
Zimpeto	An important *chapa* terminal, this terminal serves Zimpeto Market as well as the stadium. It also offers integration between all services, especially the Inter Terminal services
Albazine 1	These stations will integrate the expanded BRT and rail networks to cover the demands from these rapidly developing areas
Albazine 2	These stations will integrate the expanded BRT and rail networks to cover the demands from these rapidly developing areas
Katembe	In order to operate a simplified form of BRT – with priority on the bridge and access roads – terminal facilities will be needed. These will have feeder bus and park and ride as the tolls and congestion levels will aid in promoting modal transfer from the private vehicle to BRT

Source: JICA Project Team

Figure 8.18 shows the location of these recommended stations.

Source: JICA Project Team

Figure 8.18: Location of Recommended BRT Terminals

An example of general layout is examined for two of the stations, Estação CFM (Maputo Station) and Zimpeto.[5] Estação CFM (Maputo Station) is a terminal of major public transport services in Maputo. Zimpeto is located near the national stadium "Estádio do Zimpeto", a multi-use stadium with a capacity of 42,000 spectators opened on 23 April 2011; it also faces the "Zimpeto Market," which is one of the biggest local markets in Maputo.

Source: JICA Project Team

Figure 8.19: Estação CFM Terminal (Maputo Station)

Source: JICA Project Team

Figure 8.20: Zimpeto Terminal

[5] These are a terminal station of the proposed Zimpeto–Benfica–Brigada–Baixa BRT (or the BRT along N1), for which a prefeasibility study was conducted as part of this study.

(4) Conventional Bus Stops and Terminals

There will also be a requirement for designated bus stops, with appropriate facilities such as passenger shelters and bus laybys, along the length of every bus route. The stops must be located conveniently for the majority of passengers, but must also take into account safety considerations and the requirements of other road users.

The existing TPM bus depot and workshop in Maputo is poorly laid out and poorly located near the city centre, and ideally should be replaced. In the longer term there will be a requirement for a number of depots, which should be located towards the outskirts of Greater Maputo, in order to minimize "dead running" between the depot and routes, and to use (as far as possible) available undeveloped and less expensive land; it is likely that about ten depots will be required to cater for the needs of Greater Maputo over the next ten years.

8.8.2 Complementary Measures

In addition to the key measures identified for each of the elements of the public transport hierarchy – passenger rail, BRT, and bus systems – there are also a series of complementary measures required. These include ensuring that the public transport network is highly accessible by walking and cycling via safe, convenient, and clear routes, particularly from major public transport hubs. These should be planned and implemented directly as part of the integrated transport network for sustainable modes. Consideration of an improved pedestrian realm should be an integral part of land use planning in Greater Maputo.

Other measures include integrated ticketing, information, and marketing. Such measures are not outlined in detail in this Master Plan, but they are important for development of a sustainable transport system.

8.9 Summary of Public Transport Projects and Phasing

Table 8.4 summarizes the main public transport projects recommended in the short, medium, and long term. This requires close integration with the phasing of measures for traffic management, land use planning, and highway development.

Table 8.4: Summary of Public Transport Measures and Phasing

Category	Code	Measure	Short Term (2018)	Medium Term (2025)	Long Term (2035)
Passenger Rail	PT1	Maputo–Matola Gare Line	✓	✓	
	PT2	Maputo–Marracuene Line			✓
	PT3	Machava–Boane Line			✓
Bus Rapid Transit (BRT)	PT4	Baixa–Maguanine via Xiquelene, Praca dos Herois	✓		
	PT5	Zimpeto–Benfica–Brigada–Baixa	✓		
	PT6	Malhampswene–Ceres–Baixa		✓	
	PT7	Casa Branca–Joaquim Chissano–J.Nyerere		✓	
	PT8	Xiquelene–Museu–Baixa		✓	
	PT9	Albasine–via Cardeal A Santo (BRT1 extension)			✓
	PT10	Katembe Extension			✓
Conventional Bus	PT11	Restructuring of Public Transport Industry		✓	
	PT12	Capacity Building for the Bus Sector	✓	✓	
	PT13	Bus Network Design (including feeder services)	✓	✓	
	PT14	Bus Fleet Renewal	✓	✓	
Supporting Infrastructure and Measures	PT15	Intermodal Stops, Hubs, and Interchanges		✓	✓
	PT16	Integrated Walking and Cycling Network	✓	✓	✓
	PT17	Complementary Measures (information, marketing, ticketing)	✓	✓	

Note: For the Maputo–Matola Gare Line (PT1), project preparation is to be undertaken and project implementation to be initiated in the short term.
Source: JICA Project Team

The implementation of the mass transit components of the integrated public transport network has been set out in three major phases. Phase 1 covers the short term (to 2018; see Figure 8.21) and includes the proposed first phase of BRT covering the high demand section between Maguanine/Xiquelene/Praça dos Herois and the Baixa, and the BRT link from the N1 corridor to Baixa. This corridor offers several alternative solutions and is not given in further detail in this diagram. An additional bus only corridor is included to address traffic congestion during peak hours between Matola and Maputo. No rail is included in Phase 1 because of the short timescale.

Source: JICA Project Team

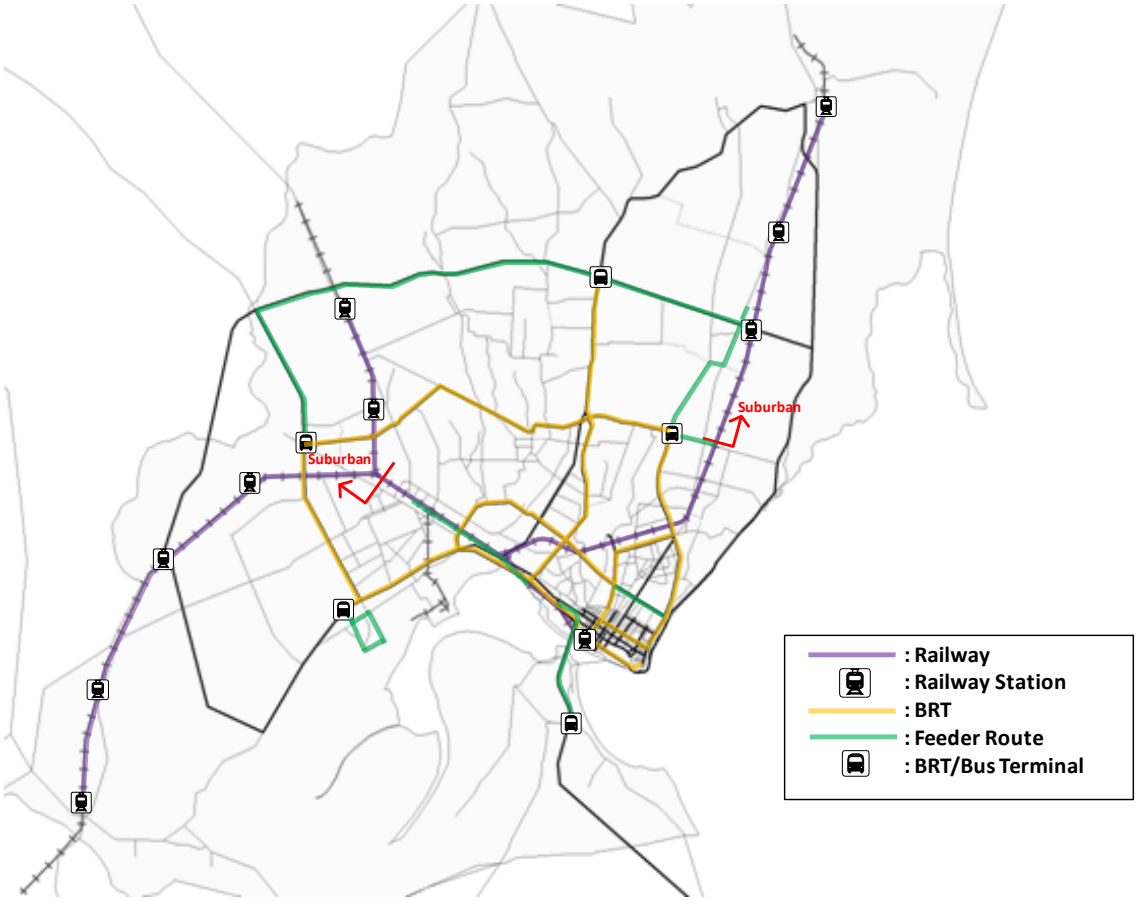
Figure 8.21: Proposed Mass Transit Network for 2018

Phase 2 covers the medium term (to 2025; see Figure 8.22) and includes the first of three passenger rail routes, the Maputo–Matola Gare Line, and the second phase of BRT development, including the main Matola–Maputo links, with two new options, one via Museu and other along the widened Joaquim Chissano Highway. Each BRT route will depend on one or more integration terminals that will receive the associated feeder routes.

Source: JICA Project Team

Figure 8.22: Proposed Mass Transit Network for 2025

Phase 3 covers the long term (to 2035; see Figure 8.23 and encompasses the complete mass transit network proposed for 2035 including all of the second and third rail lines (i.e., Maputo-Marracuene and Machava–Boane), and also the completion of the BRT system including extensions to the network (e.g., extension to Katembe via the new bridge).



Source: JICA Project Team

Figure 8.23: Proposed Mass Transit Network for 2035

Chapter 9 Improvement Plan for Traffic Control, Management, and Safety

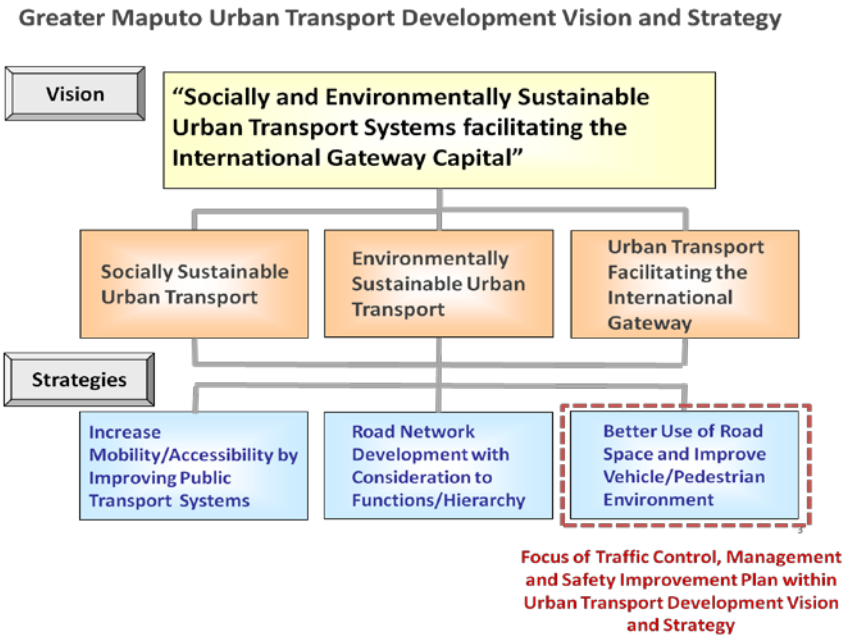
9.1 Introduction

Traffic management is essentially focused on the short term, as solutions tend to be low-cost and of rapid implementation by nature. In particular, due to the sensitive nature of the traffic and transport situation, additional attention was given to measures that could offer short-term improvements in flow (especially public transport flows) and safety (in particular pedestrian safety). Medium and long-term traffic management approaches for the Master Plan are focused more on the considerations of land use/traffic interaction, safety, and transport/traffic demand management (TDM). Full details can be found in Technical Report G "Traffic Control, Management and Safety".

9.2 Policies and Strategies for Improvement

9.2.1 Role of Traffic Control, Management and Safety in the Comprehensive Urban Transport Strategy

As outlined in Figure 9.1 below, the Traffic Control, Management and Safety Improvement Plan plays an important role in delivering the Greater Maputo comprehensive urban transport development vision and strategy. The overarching vision of "socially and environmentally sustainable urban transport systems facilitating the international gateway capital" is underpinned by three comments: i) socially sustainable urban transport; ii) environmentally sustainable urban transport; and iii) urban transport facilitating the international gateway – all of which will depend on the delivery of three strategies. One of these is "road network development with consideration to functions/hierarchy", and provides the focus for this road network development plan. The road network development plan will be supported by an integrated strategy alongside public transport and traffic management (better use of existing road space).



Source: JICA Project Team

Figure 9.1: Role of the Traffic Control, Management and Safety Improvement Plan within the Urban Transport Development Vision and Strategy

9.2.2 Principal Traffic Control, Management and Safety Policies and Strategy

The overarching policy message for traffic control, management, and safety centers on making better use of existing road space and improving vehicle and pedestrian environments.

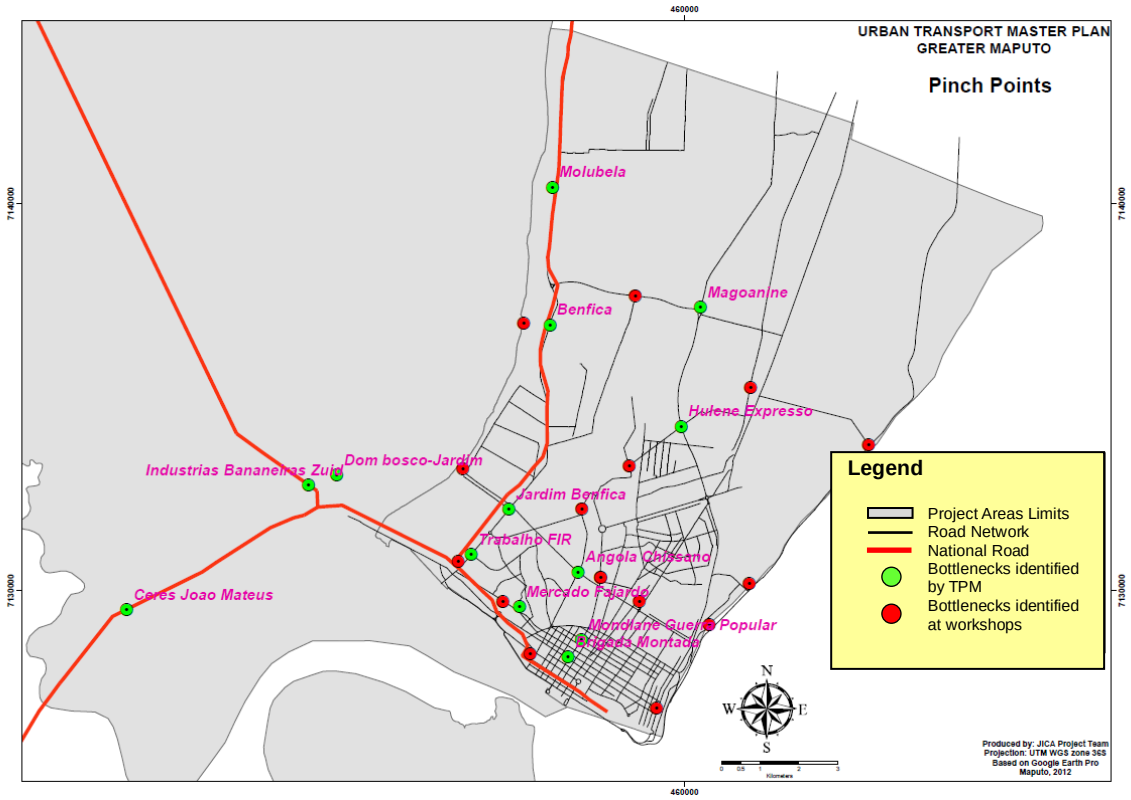
To achieve this objective, an integrated traffic control, management, and safety strategy as part of the wider master plan measures will be needed. It can include the following:

- To implement traffic management measures: including intersection improvements, an improved signal system, one-way systems, high occupancy vehicle (HOV) lanes, reversible (tidal) flow lanes, bus priority lanes, and area licensing
- To improve road safety measures to improve road and pedestrian safety and the environment: including pedestrian signals, sidewalks, road signs, road markings, safety measures for the elderly and disabled, and pedestrian malls
- To control the use of private vehicles by introducing various TDM measures: including parking management, better public transport, and controls and enforcement over road taxes and fines)
- To develop and enforce regulations: including those relating to parking, road safety, drunk driving, and speeding

These are in line with relevant policy documents such as the Five Year Government Program 2010–14, which emphasized the need to "promote the improvement of traffic road signalization" and "intensify traffic control efficiency in public roads", among others. The outputs of this approach will include the following.

- reduced traffic congestion bottlenecks/hotspots
- improved pedestrian environment (convenient, clean, healthy, and safe)
- fewer accidents
- optimized road conditions and fewer conflicts due to decreased road congestion from parking
- better connectivity and efficiency from travel control improvements (reduced delays)
- facilitation of better public transport.

The locations of major traffic bottlenecks were identified as shown in Figure 9.2, which was prepared based on experiences of TPM bus drivers and technical opinions obtained from the workshops held during the study. These were then visited 'in-situ' in order to determine the causes of the problems and prepare traffic control, management and safety measures.



Note: TPM data are shown in green, and the workshop opinions in red.
Source: JICA Project Team

Figure 9.2: Major Traffic Bottlenecks in Greater Maputo

The following sections outline the main measures to achieve the above-mentioned outputs with an associated short, medium, and long-term phasing plan.

9.3 Short-Term Interventions

An important part of the Master Plan's traffic control, management and safety plan, as identified with the key stakeholders are short-term traffic management measures. These measures will begin to address the pertinent short problems and issues, and also help pave the way for the wider medium-long term plan. The short-term traffic control, management and safety measures proposed in this Master Plan fall into several basic categories:

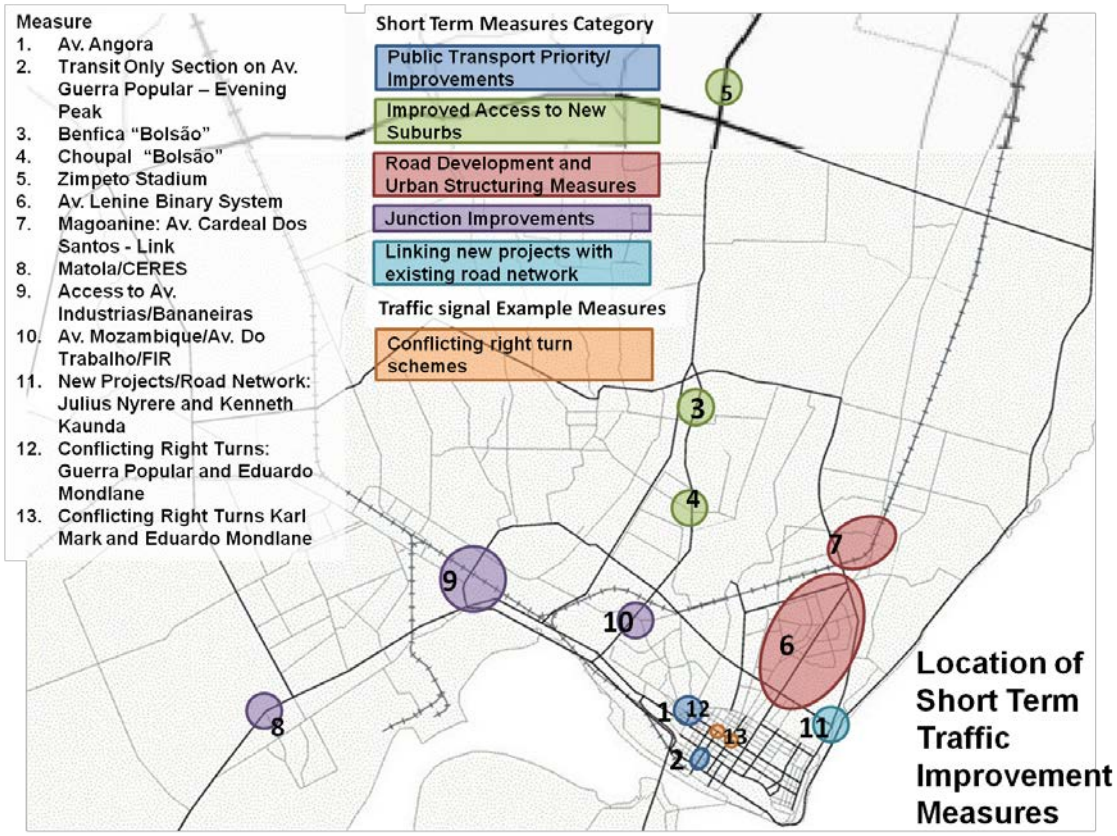
1. Junction improvements
2. Short term public transport priority and improvements
3. Improved access to the new suburbs, the "Bairros Populares" along the main highways
4. Short term road developments and urban structuring
5. Linking new projects with the existing road network

In most cases, there is a strong overlap between general traffic improvements and better public transport – as well as a positive impact on road safety. Traffic signal performance is also a crucial aspect of traffic management that affects all road users and is addressed later in this chapter.

The concept-level ideas were sketched out and presented at the second workshop in August 2012, and later discussed with the DMTT counterparts in order to assess their possible benefits,

limitations, and ease of implementation. After this consultation process, the schemes were corrected or modified as per the counterpart inputs and taken to pre-design level.

Each is described in turn below with further details and maps in Technical Report G. Figure 9.3 below provides a summary of the locations of the short-term measures.



Source: JICA Project Team

Figure 9.3: Short-Term Traffic Control, Management and Safety Measures

(1) Junction Improvements

The first category of short-term traffic management measures relate to specific junction improvements to address key bottlenecks. Three examples are introduced below.

- Matola Sede/CERES: The signalized junctions on the N2 were quoted several times in the driver's survey as major bottlenecks and should be optimized. These signals are installed and operated by Trans African Concessions (TRAC), which also prepares the junction designs (as approved by Instituto National de Viação, the National Traffic Institute, INAV). Matola does not yet have the technical expertise to install, maintain, or program signals, and signal timings are not a part of the TRAC brief. Calculations for potential the optimal signal length for this example are included in Technical Report G.
- Access to Av. Indústrias/Bananeiras: The first problem of this access is the roundabout leading to Bananeiras from the highway, which has no weaving distance between the entry ramp and exit points of the two main conflicting flows, in effect creating a junction. The situation is further complicated by the presence of long traffic queues downstream to the north. The DMTT is already discussing with TRAC the improvement

of the entry ramp. A further solution to these issues is to correct the geometry of the roundabout and leave a minimum weaving space as shown in Figure 9.4.

- Av. Mozambique/Av. do Trabalho/FIR: This bottleneck on Av. de Moçambique is largely caused by chapas and buses stopping at the junction or at the roundabout. Two short-term measures would alleviate this problem; i) improved signal timings and better use of the traffic plans available within the equipment; and ii) addition of extra lanes on the link between the highway and the roundabout.

Source: JICA Project Team

Figure 9.4: Bananeiras Highway Access: A Possible Solution

(2) Short-Term Public Transport Priority and Improvements

The second category of short-term traffic management measures relate to public transport priority and improvements. Three examples are outlined below including the N1, Av. Angola, and a public transport only section on Av. Guerra Popular.

The N1

There is an urgent need to improve public transport speeds on the N1 (Av. Moçambique). The main problems currently encountered are the haphazard loading of public transport vehicles in key areas and the encroachment of street vendors, pedestrians, and passenger queues onto the roadway. These factors have led to a rise in pedestrian accidents and a severe loss of capacity, which in turn drastically lowers peak period operating speeds.

The short-term traffic management recommendation for the N1 is to provide better access to residential districts, and help reduce encroachment by creating one-way (two-lane) crossings with no right conflicts. This will also help increase capacity and provide an improvement in public transport speeds. Such improvements are known as gyratory systems (or known as “bolsões” in Brazil).

Av. Angola

As an interim measure, the DMTT plans to implement a one-way section on Av. Angola between Joachim Chissano and Avenida Gago Coutinho from 6:00 to 8:30 as a means of improving traffic and public transport access during the morning peak. This will simplify the causes of one of the main bottlenecks, which are the right-turn movements at these signals.

However, this increased capacity will attract more traffic that will be channeled onto the remaining two-way stretch of Av. Angola; hence it may be necessary to extend this operation to the rotary traffic systems at Av. Marien Ngouabi, because the capacity of the existing system will not be sufficient to handle the full demand in the east-west directions. However, by adding a direct link and traffic signal as shown in Figure 9.5, capacity will be increased. By also making Av. Manguigana one-way from this junction, some bus routes could be diverted from Av. Eduardo Mondlane. This minimizes the congestion caused by the consequent right-turn at Guerra Popular, as well as at 24 de Julho and Guerra Popular, which still concentrates a high level of right turns in the morning peak, even with the additional lane that allows for access to Alberto Luthuli.

Source: JICA Project Team

Figure 9.5: Modification of the Av. Angola/ Marien Ngouabi Junction

Transit-Only Section on Av. Guerra Popular – Evening Peak

In the evening peak hour, thousands of passengers flock to the stretch of Av. Guerra Popular known as the Baixa, where long, disorganized queues form for the out-of-town peak trips. The concentration of passengers, pedestrians, street vendors, buses, chapas, and traffic, creates a major traffic bottleneck and, as mentioned in the section on safety, a critical “hotspot” for pedestrian accidents on Av. Zedequias Manganhela.

A simple traffic management solution is to implement a bus-only stretch of this road during the evening peak, and also separating the more formal bus stops of TPM from the chapa queues as shown in Figure 9.6.

Source: JICA Project Team

Figure 9.6: Proposed Transit-Only Section of Av. Guerra Popular

(3) Improved Access to the New Suburbs, the "Bairros Populares" along the Main Highways

Access points to these districts are notorious congestion bottlenecks with large concentrations of turning movements, chapa terminals, street vendors, and waiting passengers. A possible option would be to add a new crossing with signals, to form a one-way system that channels right-turns away from the junction and permits the development of bus/chapa terminals off the main highway.

This action attracts both informal transport and vendors away from the highway, leading to an enormous improvement in pedestrian safety, which is a major concern in these zones as shown in the later section on safety. Capacity gains can reach some 200% due to the banning of right turns and the doubling of effective width on the one-way side roads.

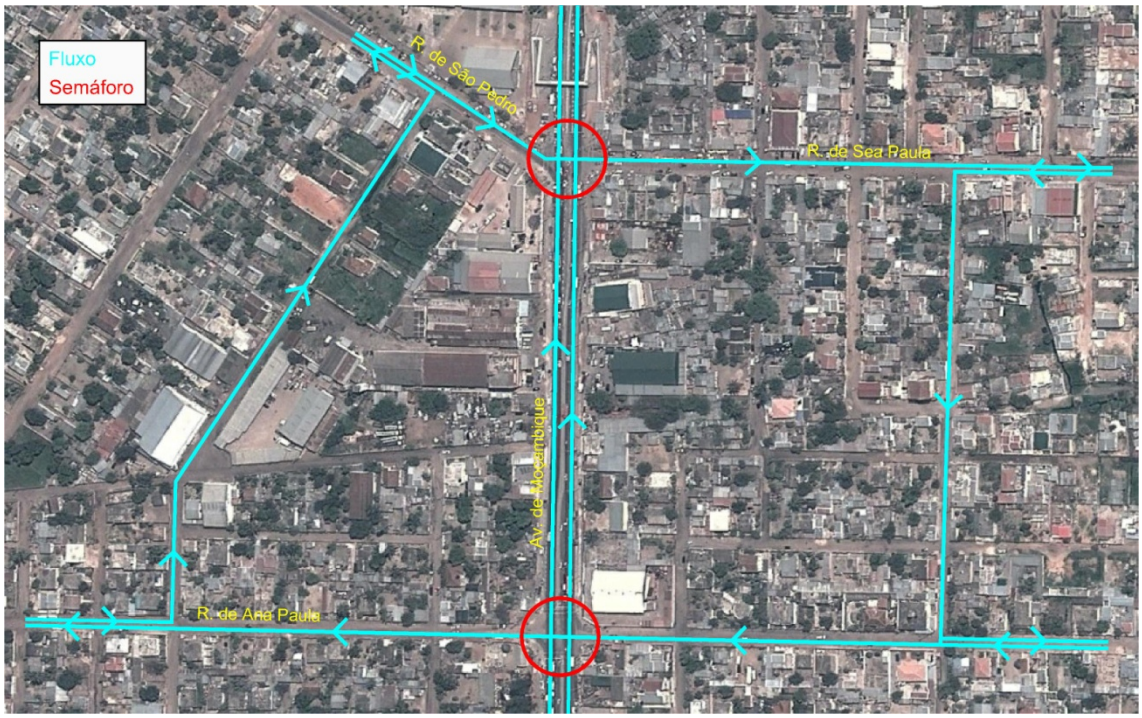
Benfica

An example measure contemplates two crossing points for Benfica on the N1. The new roads to be opened or modified are the road on east side, and the link between the roads to the north, where limited resettlement takes place. This location was also found to be a pedestrian accident hotspot and the two crossings would also help to allow pedestrians and passengers to cross with fewer conflicting traffic flows.

Importantly, the actual volumes (about 1,000 cars and 300 chapas) are well within the capacity of a two-lane highway, provided the disruption caused by chapa queues, street markets, and general encroachment can be reduced.

Choupal

A similar situation exists at Choupal (Ruas São Pedro/Ana Paula). Access to the districts on both sides of the highway could be managed by an improved design of the gyratory type as shown in Figure 9.7



Source: JICA Project Team

Figure 9.7: Access to New Districts: Choupal

Zimpeto

The rapidly expanding districts of Zimpeto have both access and accident issues. The Mercado Grossista zone, for example, was specifically cited as a major pedestrian accident zone. When the stadium is fully operational, it will also suffer from access problems at the junction with the N1, as entering the stadium will cause major traffic congestion at the right turn from the N1 and exiting will require at least two free lanes at the N1 junction.

A short-term, low-cost solution for all these issues could be the formation of a gyratory, reversible system for stadium access, with one traffic signal only for east-west and pedestrian crossing flows. This would allow traffic from the stadium two lanes to turn at all times onto the N1 (southbound) and at least one lane northbound.

(4) Short-Term Road Development and Urban Structuring Measures

The fourth category of short term traffic management measures relate to the concept of road development and "urban structuring."[1] This simply refers to the concept of integrated planning and review of the following elements for cities undergoing rapid or explosive growth and transformation; (i) road network, (ii) the public transport network, (iii) land use planning, and (iv) preservation of green areas. Of these, the road network has the greatest impact on the structure of the city, since accessibility is always a primary urban requirement. In many cases, it is not applicable to construct wide access roads through informally occupied areas or older

[1] The School of Urban Planning, Curitiba, Brazil.

residential zones, either in terms of cost or environmental damage. As a result, the option of low-cost accessibility is encouraged, using one-way binary road pairs. Thus, a development axis can be formed with four lanes by using two one-way streets of 8 m paved width. Two examples are summarized below.

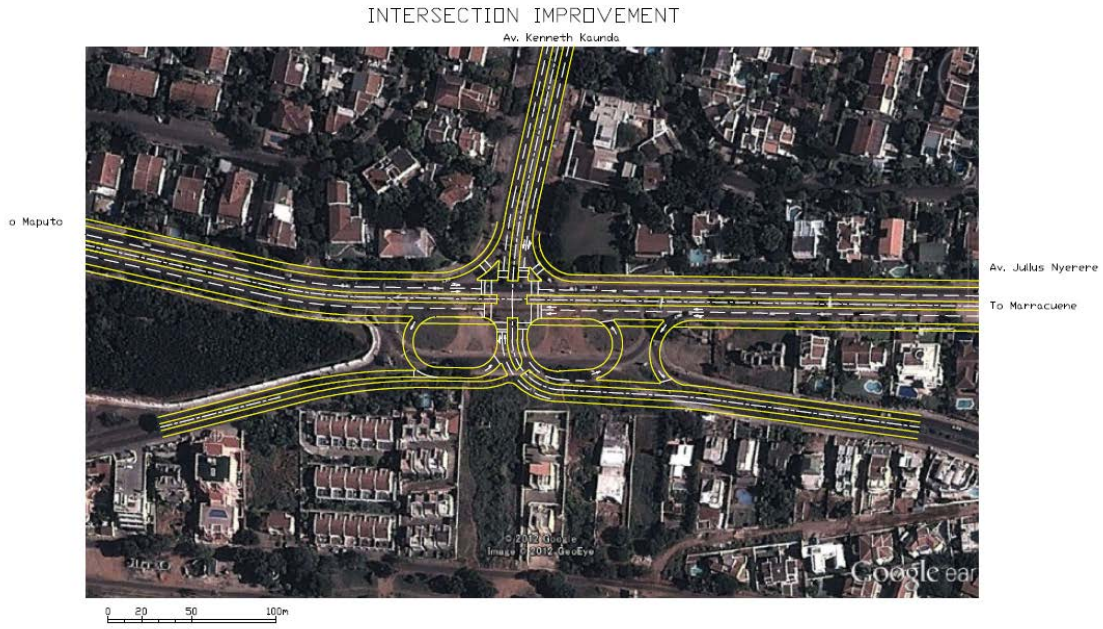
- Av. Lenine Binary System: An example of the use of this binary (pair of one-way roads) technique could be the stretch of Av. Vladimir Lenine that passes through the popular districts from the city centre to Combatentes, via a complicated crossing with three roads at Primeiro de Maio. To simplify this road structure, a binary could be formed with Resistência St., each operating one-way. The latter is a wide, paved, but little used road that ends at the Escola Industrial.
- Hulene Expresso/Magoanine: This section of the main Julius Nyerere Highway to Marracuene has a major bottleneck at the junction with the Rua da Beira, which was repeatedly cited during the driver surveys and the stakeholder workshops. As with many signalized junctions, the signal timings could be improved. However, the problem in terms of overall structure is that the areas on both sides of the highway have to rely exclusively on this one access to and from the highway therefore compounding the bottleneck. This leads to an excess of right turns at the junction causing additional congestion. A solution of the gyratory type mentioned earlier type would require large-scale resettlement, as no existing road system is available. Therefore, to counter this issue, the district could offer a new access on Av. Cardeal Alexandre dos Santos – a wide road that runs for several kilometers to the east of the district and that is planned to be paved, but which is not integrated with the highway network. To fully reap the potential benefits of this paving, a better quality link to the main road is needed, by using the right-of-way of the railway and by opening a short stretch of informal settlement next to the football ground. This new road would exit at a signalized junction next to the rail overpass.

(5) Linking New Projects with the Existing Road Network

The final category of short-term measures are those linking new projects with the existing road network. Several major road works are in the process of being rolled out of which the Av. Marginal and Katembe Bridge/Ring Road are the most significant. The possibility of using a small part of the space of the access roads to the bridge and the Maputo–Matola section of the Ring Road for the introduction of a complementary express 7 m wide public transport corridor is discussed in Chapter 8.

The linking of the Av. Marginal toll road to the existing road network is complex, with the first bottleneck next to the Radisson Hotel, where three conflicting flows meet. The final toll road designs need to thus incorporate two lanes for the major flows (southwest-north, north-southwest). To avoid a three-stage traffic signal, it is recommended that the southwest-northwest movement be eliminated and transferred to the junction 900 m to the south. Thus, the signals would operate with two stages with short pedestrian phases on the left turns. Any solution would have to contemplate signals due to the traffic conflicts and need for pedestrian access.

From the north, the traffic then encounters the oblong gyratory at the junction of Julius Nyerere and Kenneth Kaunda. At present, this junction has sufficient capacity to handle the traffic demand; however, with the opening of the stretch of Julius Nyerere (blocked in the landslide and now undergoing reconstruction) and the future addition of a potential BRT corridor, this will no longer be a feasible option. The suggestion is to modify the junction with three approach lanes for the westbound traffic and signals to handle the main movements as shown in Figure 9.8.



Source: JICA Project Team

Figure 9.8: Av. Marginal, Access to Av. Julius Nyerere and Kenneth Kaunda Junction

9.4 Traffic Signals

Signals have been identified as major bottlenecks, due largely to the following main factors:

- Signals are at junctions that tend to have a concentration of chapa stops, and these stops in turn create queues that attract street vendors as well as pedestrian crossing flows. As the chapa drivers do not like to stop twice, all loading and unloading tends to take place on the signal approaches, greatly diminishing effective green time.
- Most junctions also operate with all movements permitted, causing "locking" between conflicting right turns and the blocking of approaches.
- In the central area the signals operate (with few exceptions) without synchronization, causing long queues and waiting times.

Therefore, a comprehensive set of measures is needed. These are described in turn below, including an explanation for each of the following.

- Warrants for signals
- Solutions for conflicting right turns
- An Area Traffic Control System
- Bilateral agreements on maintenance and timings

9.4.1 Warrants for Signals

It is essential that Greater Maputo traffic departments have a clear set of warrants to justify the use of signals. If possible, these warrants should be approved by the local government bodies (elected and executive) so that requests for signals on sites that do not need them can be granted or refused according to pre-discussed rules – and not just on the personalized decision of the head of the traffic department.

Traffic signals may be justified if, usually two, of the following criteria are present.

a) where there is a minimum major-street/minor-street conflicting vehicle volume
b) where there may be need to interrupt continuous flow on the major road to allow traffic to exit from the minor road without excessive delay
c) where a minimum pedestrian volume conflicts with a minimum vehicle volume
d) where a schoolchildren crossing is present
e) where there is a need to maintain progressive movement of vehicles along an otherwise signaled route
f) where there is a record of accidents of the type that could be reduced by the use of traffic signals

Therefore a common set of warrants could include:

- Traffic flows: when there is a minimum of 1,500 PCUs per hour entering the junction during the peak hours
- Visibility: when drivers on the minor road have poor visibility for judging gaps
- Accidents: when three or more accidents (collisions or pedestrians) are registered per year

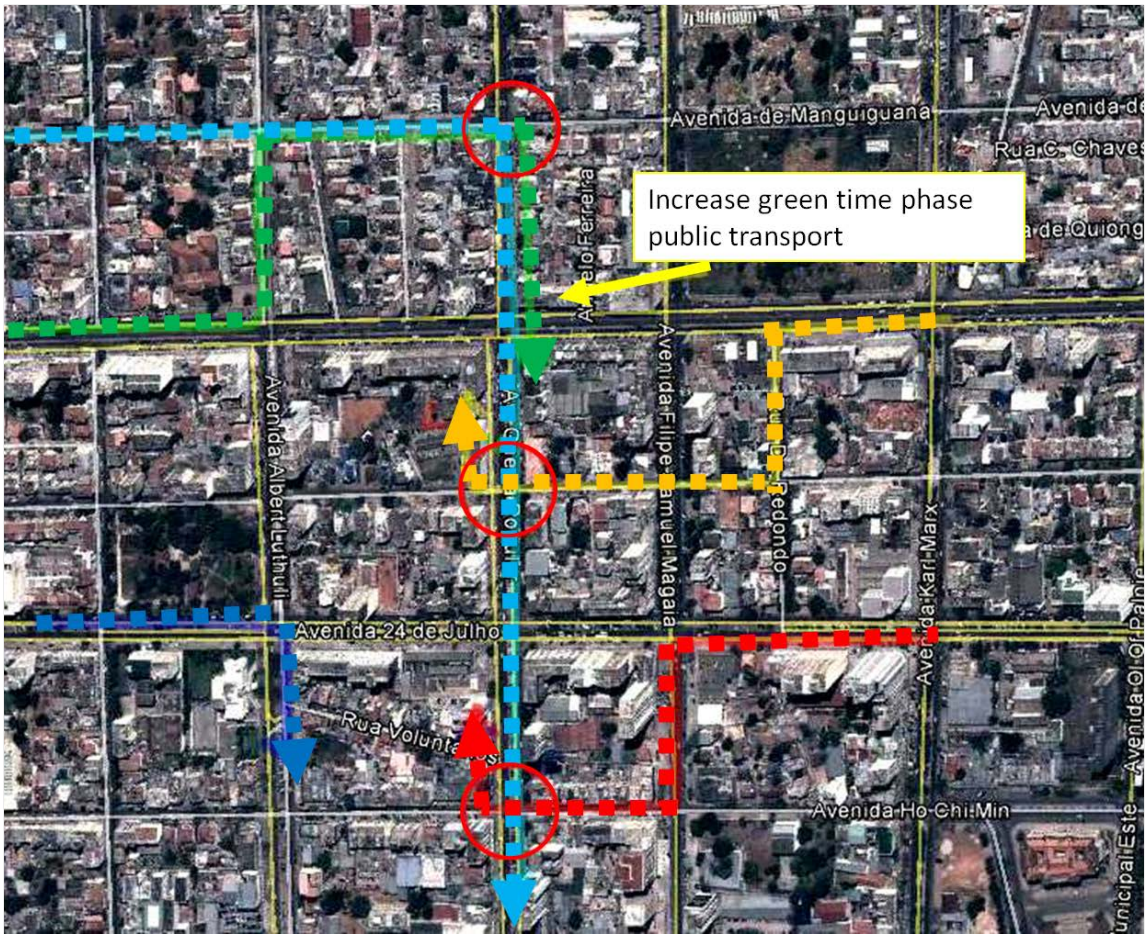
9.4.2 Solutions for Conflicting Right-Turns

There is no doubt that the continued allowance of right turns in the Maputo city centre will no longer be viable in the short to medium term as traffic volumes increase. In order to prevent loss of capacity due to the need for a queuing lane, the loss of green times, and the conflicts with pedestrian flows all associated with right turns, the solutions (as universally adopted in big cities worldwide) is to ban these movements. They should be replaced "P" or "G" movements that one-way systems permit. A "P" movement uses three left turns to effect a banned right turn; a "G" movement uses a left turn and two right turns at non-critical intersections. An example solution in Maputo is discussed below.

Example Scheme: Priority for Guerra Popular

Guerra Popular where there are number of constraining right hand turns at the junctions of Avenidas Guerra Popular/Eduardo Mondlane/24 de Julho (as analyzed in Technical Report G) provides the first solution measure.

Figure 9.9 below shows that the substitution of these right turns will need the addition of three new light-controlled junctions, which are indicated by red circles. The timing and coordination of these would thus be necessary as part of the Area Traffic Control system. In the morning peak, if Av. Manguigana were used as a more direct public transport link, an increased green time allocated to Guerra Popular at both Eduardo Mondlane and 24 de Julho would be incorporated. The new right turn options to reduce bottlenecks on Guerra Popular are also shown.



LEGEND

- Direct transit route from Av. Angola (modified)
- Right Turn option for traffic and transit at Guerra Popular Junction (W-S)
- Right Turn option for traffic and transit at Guerra Popular Junction (E-N)
- Right Turn option for 24 de Julho and Guerra Popular
- Morning Peak right turn available via reversed flow lanes
- New controlled junctions

Source: JICA Project Team

Figure 9.9: Elimination of Right Turns along Av. Guerra Popular

9.4.3 Area Traffic Control System

The proposed short/medium-term traffic signal control system is envisaged as an Adaptive Signal Control (ASC) type system, initially using traffic plans optimized on a 24-hour/365-day basis. These solutions measures have been agreed with DMTT and also put forward as part of the Pro-Maputo Program. More details are outlined below.

The main benefits of (ASC) technology over conventional signal systems are that it enable the following.

- Continuously distribute green light time equitably for all traffic movements
- Improve travel time reliability by progressively moving vehicles through green lights

- Reduce congestion by creating smoother flow
- Prolong the effectiveness of traffic signal timing

The Control System for Adaptive Real-Time Traffic encompasses a set hardware/software that allows a greater flexibility of operation of the traffic lights through the use of a computer, remote communications, and online controllers to a central control, and the use of a specific program for automatic control. The Operator/System Interface must be user-friendly, have different levels of access, and be easy to install and maintain.

The intelligence of the system is distributed in three hierarchical levels, resulting in greater reliability in the event of problems of communication.

- The first level is represented by the signal controllers, which, among other functions, are responsible for the activation of the lights at intersections.
- The second level, represented by the GSM/GPRS module[2] installed in the field, has the primary responsibility for transmitting information.
- The Control Centre will have the following main responsibilities:
  - Monitor the traffic situation
  - Monitor the status of the equipment
  - Calculation of signal timings

The traffic management software must be equipped with built-in graphics, allowing visualization of the level of fluidity of intersections, corridors, sub-areas, and all controlled area.

The Maputo Traffic Control System will probably have a minimum of data collection and thus will depend on the use of pre-planned timings calculated offline. These will also have to take into account the large pedestrian flows and public transport movements (both of chapas and passengers). Therefore, an essential short-term measure is the preparation of basic peak traffic counts that can evaluate the changes in flows as a result of the circulation modifications and the training and software needed to optimize movements and manage localized congestion.

The Control Centre for Operations (CCO) is part of the ProMaputo II Program. The new space for the centre, on the 11th floor of a central area building, is near completion and will include staff from the Municipal Police as well as the Fire Brigade. As well as handling the Area Traffic Signal Control system, the fibre-optic and GPRS network will offer Variable Message Signs (VMS).

9.4.4 BRT Priority

The proposed future traffic plans should be calculated so as to prioritize the proposed BRT public transportation system, on shared road space or exclusive track. The Traffic Control System must have mechanisms to increase the priority given to these vehicles. The systems that are generally offered for BRT priority include:

a) The use of BUSTRANSYT[3] and other models that use the standard unit stopping times at stations and vehicle characteristics to simulate flows and improve peak and overall BRT speeds through correct signal timings and progressions/synchronization

[2] The Global System for Mobile Communications (GSM) and the faster General Packet Radio Service (GPRS) are two types of modems commonly used to enable cell phones to handle data transmission functions.

[3] Bus transit is a computer program which calculates traffic signal timings that give buses priority in a network of linked fixed-time signals

b) The use of electronic 'tags' on the BRT units that identify the bus allow for real-time preference at signaled junctions, either by extending the BRT green phase when the unit is approaching or by shortening the transverse green phase when the unit approaches on red.

The use of GPS data to monitor the position of each BRT unit and check on operational problems is normally part of the Fleet Control Package and GPS data.

9.4.5 Medium-Term Traffic Signal Expansion

While in developed countries the number of traffic signals tends to be a function of population size, in rapidly developing economies this is not the case as car ownership also rises with increased income. The current number of signals in Maputo is 80, but this certainly underestimates the true need for signals since based on recent traffic growth it can be expected that the need and demand for signals will rise exponentially. Technical Report G sets outs initial calculations of the estimated number of new signals aligned with forecast population growth.

These new signals would also contemplate the opening of new junctions in order to create a network of one-way streets that can handle turning "P" and "G" movements as defined earlier in section 9.4.2, eliminating the need for right turns and right-turn signals. In particular, these flows lead to a loss of capacity and high pedestrian risk (see Section 9.5 on safety) and with the new options can be banned at the crossings of Karl Marx and Guerra Popular with Eduardo Mondlane and 24 de Julho.

9.4.6 Bilateral Agreements on Maintenance and Timings

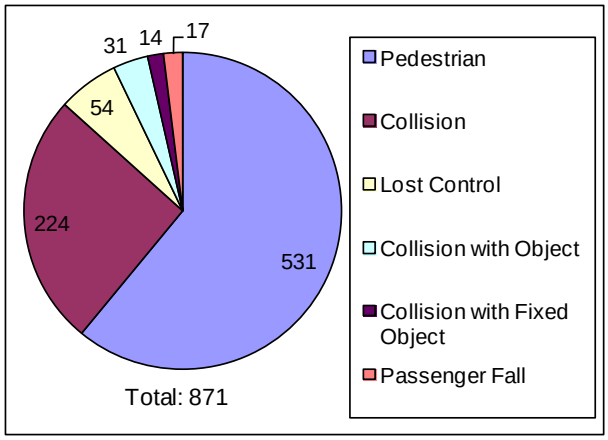
The problems of signal timings and maintenance of the signals within Greater Maputo but in other jurisdictions (in particular, Matola and TRAC/INAV) need to be handled either through bilateral agreements that include basic responsibilities and costs or via a metropolitan transport body. As a simple issue that involves relatively low costs and avoids more thorny questions relating to transport services, such agreements could form the working model for other agreements along similar lines.

An inter-governmental group proposed the formation of a metropolitan transport agency at the end of 2012 in which this issue of signal maintenance, timings/programming and supervision would be handled. These issues, as are shown in Technical Report G, are a major cause of delays and loss of public transport capacity, yet can be effectively resolved in a question of days and with very limited funds and materials.

The on-street traffic controllers have the capacity for 4 or more traffic plans although at most sites only one plan is in operation. By re-programming the cycle and green times, the efficiency of the junction infrastructure can be greatly improved.

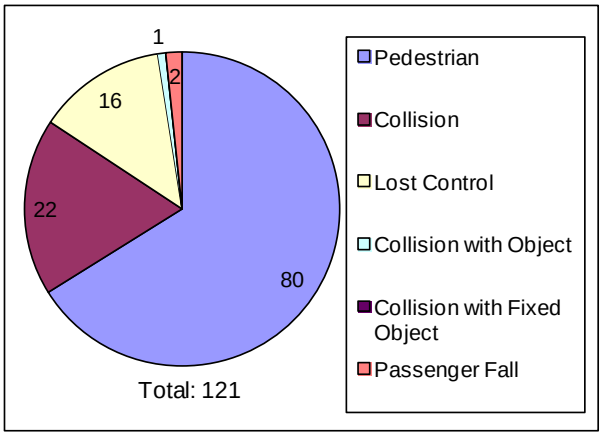
9.5 Traffic Accidents and Road Safety Measures

While traffic accident data are significantly underdeveloped in Greater Maputo (thus requiring the development of systematic accident database as proposed in this section), it is widely recognized that the increases in traffic volumes and car ownership have greatly increased the number and severity of accidents. Figures 9.10 and 9.11 show the accident data in 2011 obtained from Polícia da República de Moçambique (PRM) – Maputo although the Maputo police mentioned that these numbers are highly under-reported.



Source: Polícia da República de Moçambique (PRM)–Maputo

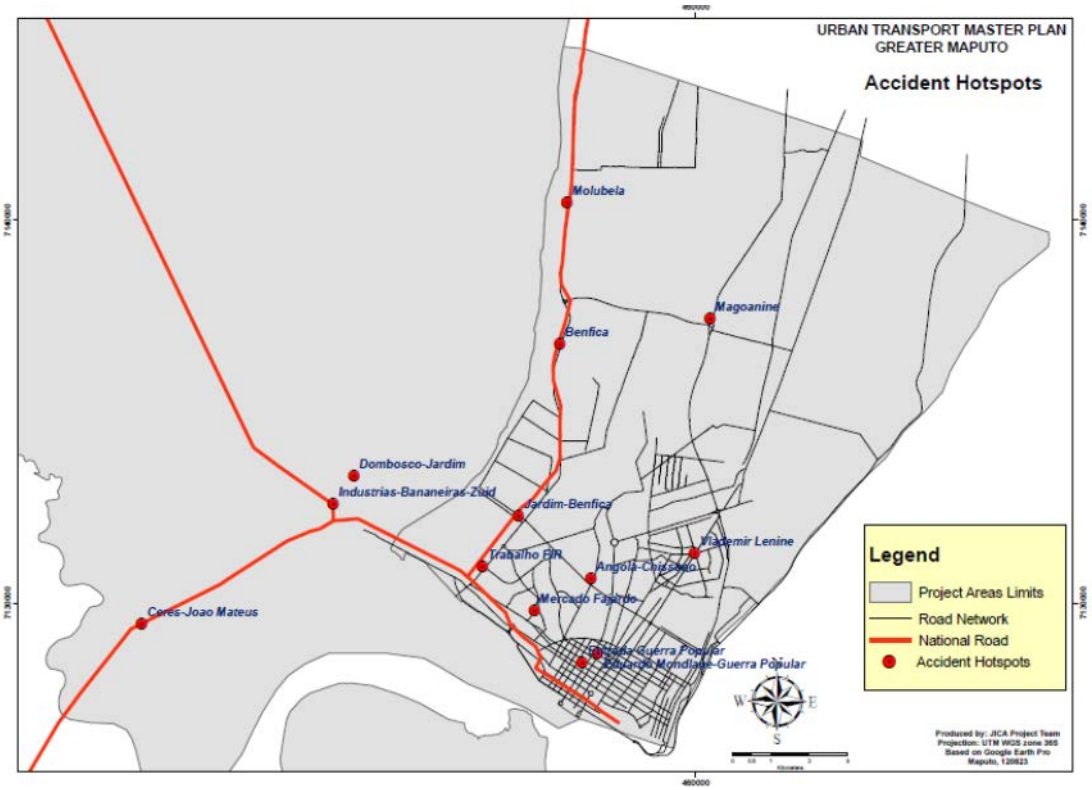
Figure 9.10: Number of Traffic Accidents in Maputo City, 2011



Source: PRM–Maputo

Figure 9.11: Number of Fatalities in Maputo City, 2011

Figure 9.12 presents a map of traffic accident hotspots (locations with high accident rates) prepared based on information from the Maputo police.



Source: PRM–Maputo and JICA Project Team

Figure 9.12: Traffic Accident Hotspots

These hotspots are included in the major traffic bottlenecks presented in Figure 9.2, with a large number of pedestrians, public transport passengers, street vendors, and/or chapas. It is expected that the traffic management measures proposed in the previous sections will greatly improve the safety conditions at these hotspots. These measures include the following:

- Implementation of one-way system that will remove right-turn conflicts at major junctions, which are an important cause of the main bottlenecks
- Introduction of transit-only sections with separation of the more formal bus stops of TPM from the chapa queues
- Banning of right turns at major junctions by adding a new crossing with signals that will handle the traffic requiring right turns
- Use of a binary system (i.e., a pair of one-way roads that will carry traffic in opposite directions)
- Intersection improvements including those presented in previous sections to remove major traffic bottlenecks, thereby improving the safety conditions at the intersections
- Improvement and expansion of traffic signals

While these traffic management measures are expected to contribute to safety improvements, some specific additional measures are required as outlined below.

9.5.1 Digital Database

One of the most important proposals is the creation of a unified and digital accident database that will allow the metropolitan transport and traffic bodies as well as the Polícia da República de. Moçambique (PRM) to assess the available data and determine the location of accidents, the degree of risk, probable causes, and eventual effects of safety measures and solutions. The supply of software, the training of staff, and the initial startup of an accident database are tasks ideally suited for technical assistance. If this is not a possibility, the use of spreadsheets has been shown to be a useful tool in data analysis.

9.5.2 Pedestrian Measures

The accident hotspot locations were visited and checked to see if any specific remedial measures could be put in place. The pedestrian bridges and separation projects at Benfica and Choupal are good examples of the efforts being undertaken by the authorities to reduce conflicts, although for the latter it is not yet clear if the junction will remain open or be closed to east-west traffic. If left open, pedestrians will continue to use the road space rather than the overpass and the accident hotspot will continue to exist.

Pedestrian improvements are part of the traffic measures at Benfica, Choupal, and along the Guerra Popular crossings. Magoanine and Xiquelene are treated as part of the BRT proposals. The evening peak bus-only section of Guerra Popular should reduce conflicts at the junction of Zedequias Manganhela, although a much more far-reaching program of reducing the sidewalk space occupied by illegal/abusive parking and street vendors needs to be undertaken.

Although the section of the N4 known as Maquinac has a pedestrian overpass linking the transit stop areas that make use of the gradient to minimize ramp height, many pedestrians still cross making use of the median. This problem was originally addressed by TRAC with a section of fencing, which the local population promptly pulled down. This does not mean, however, that TRAC should not make additional efforts to remedy a known accident hotspot. It is suggested that the median be modified to include a New Jersey concrete barrier (i.e., a modular concrete barrier employed to separate lanes of traffic).

9.5.3 Alcohol-Related Accidents

Accidents related to alcohol represent a major cultural challenge for many developing countries. There is a wealth of recent experience in countries with similar backgrounds to utilize for

Greater Maptuo. In the regional sphere, the Arrive Alive program has shown how to address this problem in terms of legislation, equipment, and approach; and in Brazil similar initiatives have shown from a public relations perspective how to make this an unacceptable social habit.

9.5.4 Better Driver Training and Education

The quality of driving standards is varied, but in general many drivers lack a clear notion of safer driving and basic discipline. New drivers in the metropolitan area may require stricter testing and after a certain number or type of traffic offences (i.e., the almost universal demerit points system based on registered traffic violations), the proposed Greater Maputo Metropolitan Transport Agency[4] may require that the offender undergo a recycling course and pass a new test. Retesting every five years or so to guarantee that the driver maintains the necessary psychological and visual skills will also minimize the presence of poor and antisocial driving. As well as reducing the overall number of private vehicle users, better testing will improve the overall traffic culture and lead to smoother and safer traffic flows.

In cultures with high accident rates, a small investment by a company in defensive driving can have a large cost/benefit ratio, unlike countries with a safe accident record, where training does not have a high impact on company risk.

Safer driving courses and training is an area in which, traditionally, the suppliers of trucks, cars, and buses have supported as institutional public relations (e.g., the Volvo Road Safety Programs). This is also an area highly suited for technical assistance.

9.5.5 Greater Control of the Fleet

An overarching measure required is the application of a stricter technical revision of the quality of the vehicles in circulation. Again, this would be handled by the proposed GMMTA under contract or concession. The controls would focus on safety aspects such as steering, brakes, tires, and lights. At a later stage environmental considerations could be added in order to minimize pollution levels.

9.5.6 Electronic Enforcement

Finally, as part of overall safety measures and general fleet controls, it is envisaged that electronic enforcement will be introduced in the medium term. This is expected to cover the following.

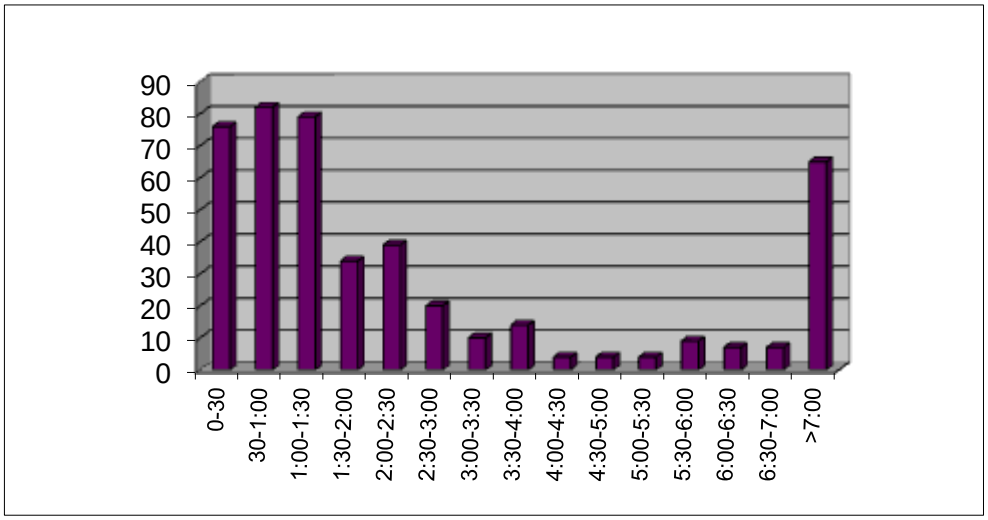
- Speed controls at known accident hotspots, including electronic speed humps where pedestrians are at risk and speeds should be reduced to, 60 kph or even 40 kph
- Weight controls on highways where overloading is causing accident risk and extreme pavement damage
- Encroachment of BRT lanes
- Electronic breath testers for checks on drinking and driving with direct links to the Control Centre for Operations (CCO) and tax/fine registry

[4] As explained in Chapter 8, the proposed GMMTA will mainly be a recommendatory and coordination body with some exceptions and all modes and aspects of transport including public transport the Greater Maputo Metropolitan Area will be addressed by the agency. The aim is to ensure effective implementation and coordination of the various transport and traffic measures undertaken by relevant agencies in the Greater Maputo Metropolitan Area.

9.6 Parking

9.6.1 Parking Control and Management

The control of on-street parking is one of the most important measures for Traffic Demand Management, improvement of overall traffic flows and the adequate provision of space for pedestrian movement. Rapid increase in car ownership has led to the encroachment of available central urban spaces by parked cars and the city has initiated a paid-parking scheme (termed 'Rotativo') that, together with the relevant adaptations to the Traffic Laws, offers the chance to recuperate control over these areas. The key to any on-street scheme is to allow each space to be used by a greater number of users for short-term parking. This guarantees that commerce and services in the city centre will be accessible to clients. According to the survey of unpaid on-street parking conducted in this study (at locations still not included in the 'Rotativo' system), there is a strong short-term demand of up to two hours coupled with a high long-term (over 7 hours) demand.



Note: These are total numbers of parked cars in the four locations surveyed.
Source: JICA Project Team

Figure 9.13: Parking Duration in the Unpaid On-Street Locations: Total Cars per Period

The short-term rotation scheme, 'Rotativo', promotes short-term parking by the obligatory rotation of demand on marked spaces. This scheme is intended to cover most of the central business district, and is currently undergoing roll-out.

The biggest risk to the system is that users who don't pay or overstay are not fined or clamped.

According to the data for the month of June 2012 as supplied by the 'Rotativo' operator, the unpaid rotation is relatively high, accounting for about 42% of all rotations, indicating that a number of users are not paying for the system. An enforcement company supplied several trucks and 100 clamps, but they started to be used to enforce illegal parking in general.

The new Highway Code of 23 March 2011 covers the issue of both illegal and paid parking quite extensively (see Box 9.1 for details). For example, the articles make it clear that any parking in the 'Rotativo' zones that is unpaid or that extends beyond a two hour grace period is considered to be 'abusive' and subject to the use of enforcement through clamping.

Clamping is certainly an essential enforcement tool for guaranteeing the success of any parking policy, but the lack of criteria in selecting the target cars and offenses causes a high level of public resentment, which may lead to the abandonment of the policy of clamping.

According to the Comandante of the Maputo Municipal Police, the volume of illegal parking in Maputo is extremely high and thus the orientation is to analyze each situation and clamp only those in "worst" or abusive situation, concentrating first on the central professional and commercial zones and where traffic – both of vehicles and pedestrians – is seriously obstructed.

In view of these situations, a realistic recommendation is the following:

- The rules and guidance need to be clearly set out, and in the short term, enforcement (clamping) should be restricted to:
  - ✓ Abuse of the Rotativo parking system (or similar paid parking schemes) as defined by municipal by-laws and the Highway Code; and
  - ✓ Obstruction of the roadway by clearly indicated illegal parking.
- For the above enforcement, adequate training should be provided for the traffic police and enforcement work force that may be recruited.
- The rules should be communicated to the public as part of the traffic public relations in Greater Maputo. For this to be successful, preparation for public opinions to be received should be undertaken.
- In the medium term, the target of enforcement should be widened, and the enforcement capacity of traffic police should be strengthened through increased personnel and budgetary allocations and the provision of adequate training.

Box 9.1: New Highway Code of 23 March 2011

The items of the new Highway Code that are directly related to the parking issues are as follows:

ARTICLE 51-(Prohibition of parking)

1. Parking is prohibited:

h) Parking areas of limited duration when the rules are not fulfilled;

ARTICLE 70-(Parking and parking areas)

2. The exclusive allocation of parking areas for vehicles of a certain class or type and time limitation of parking, as well as the establishment of a fee to be charged through agents or mechanical means adequate, are covered by regulation/decree (by laws).

ARTICLE 71-(Forbidden parking)

1. In parking areas it is prohibited to park:

c) Vehicles of a class or type other than those for which the parking area has been exclusively dedicated, pursuant to the preceding article;

d) For longer than the time limits, or without the payment of the fee fixed in accordance with the preceding article.

2. The contravention of the provisions of the preceding paragraph shall be punished with a fine of 750.00 Mt.

ARTICLE 163-(Abusive or improper parking)

1. Abusive parking is considered to be:

c) Of a vehicle in a parking zone subject to the payment of a fee, when this has not been paid or is two hours beyond the period of time paid;

d) Of a vehicle that remains in a determined parking place for more than two hours beyond the allowed time period;

ARTICLE 164-(Blocking, removal and storage of vehicles)

1. Vehicles may be removed that are either:

a) Considered to be abusive parking as per the previous article;

c) Parked or detained in a manner which would constitute evident danger or serious disturbances to the public transport;

2. For the purposes of point c), the provisions of the preceding paragraph shall be deemed to constitute evident danger or serious disturbances to the public transport, inter alia, the following cases of parking or detained:

a) In a via or corridor reserved for public transport;

b) In the stop zone of public transport vehicles;

c) On pedestrian crossings;

d) On areas reserved exclusively for pedestrian traffic;

e) On the carriageway, distant from the kerb;

f) In places of access to properties, garages or parking places;

g) In places reserved for the parking of vehicles of certain categories or assigned to loading and unloading operations or the embarkation or set down of passengers;

h) Preventing the formation of one or two lanes of traffic, where this can take place in one or two directions;

i) Double parked on the carriageway;

3. In the situations referred to in points a), b) and c) of paragraph 1, the competent authorities responsible for supervision can 'block' or clamp the vehicle through suitable device, preventing its movement until it can proceed with the removal.

4. In the situation referred to in point c) of paragraph 1, where it is not possible to immediate removal, supervisory authorities should also proceed with the provisional movement of the vehicle to another location, to be blocked until removal.

5. The liberation of the vehicle can only be carried out by the competent authorities and is subject to a fine of 2,000 Mt .

6. Whoever owns, with reservation of ownership, tenant, lessee under a finance lease, the lessee for a period exceeding one year or who, by virtue of that subject to registration, has ownership of the vehicle, is responsible for all costs incurred by the removal.

7. The conditions and fees payable for the blocking, removal and confiscation of vehicles shall be laid down by regulation (by-law).

8. Fees are not due when it is established that application of the legal sanctions was incorrect.

9.6.2 Expansion of the 'Rotativo' System

As mentioned above, the 'Rotativo' system is the principal traffic demand management tool available to Maputo city and there is a direct benefit to the commercial life of the city in having a guaranteed supply of short-term bays.

After full rollout of the proposed zones south of 24 de Julho, the existing areas could be gradually augmented with the addition of the new areas, according to the demand studies carried out by the operator and the DMTT.

Pricing will have to be such that the system maintains financial stability and that there is an adequate number of free bays to be used. If the cost becomes too low, there is a tendency for all bays to operate at full capacity and force excess drivers waiting for spaces and causing delays and additional congestion.

9.6.3 Special Access and Other Reserved Bays

In the short to medium term, the system should introduce the concept of bays reserved specifically for vehicles adapted for people with special needs or over a certain age. This is discussed in the draft regulation below.

9.6.4 Sidewalk Parking

Sidewalk parking has become widespread. In particular, residents prefer to park at night in groups on the sidewalk (under the eye of a private watchman), where damage and theft can be kept as low as possible. This forces pedestrians – starting at about 6:00 pm – to squeeze between cars or walk in the roadway. During the day there is also often no adequate corridor for pedestrian movements due to cars and trucks obstructing the sidewalk.

Sidewalk maintenance is also a major problem that is exacerbated by the passage of (and consequent damage caused by) vehicles on the sidewalk surface. Normally in countries with a Latin-based legal system, the owner of the building fronting the sidewalk is responsible for its upkeep. If this maintenance is not carried out, it is undertaken by the city and the cost added to the annual property tax.

In extreme situations, physical barriers can be used to reserve pedestrian space. This technique is already used in front of several buildings based on local initiative, such as the British Council building, but questions of sidewalk maintenance, obstructions to high pedestrian flows, and the regularized use of bollards need to be clarified.

9.6.5 Proposals for Regulation on Parking and Land Use

The relationship between parking and land use, has been identified with stakeholders as an important consideration, particularly the question of how to incorporate parking needs within a land use ordinance, specifically the situation of major traffic generators and parking by proposed land use (planning permission). The following items seek to outline an overview of the general considerations required.

Parking and Land Use

Given the present and forecast growth rate of car ownership, there is a need for better definition of major traffic-generating activities, as well as the amount of bays offered by enterprises. Therefore, it should be mandatory to reserve bays intended for the parking of vehicles linked to any new enterprise and its activity. To minimize soil impermeability and ensure an adequate environmental setting, it is necessary to require tree planting in large parking areas. To facilitate pedestrian movement, it is necessary to separate vehicle access to large parking areas. A set of parking standards should be followed, including examples such as those below.

- Parking bay size; including space for access, movement, and maneuvering)
- Parking space allocation for disabled people

- The following standards should be met: A standard minimum dimension of bays and be free of any obstacles;
- Non-covered parking lots should also have standards for tree plantation to to guarantee permeability, shade, and landscaping
- Access corridors and circulation of vehicles should have minimum widths, according the angle formed in relation to bays
- Inbound and outbound access standards.

Treatment of Major Traffic Generators

Certain developments may impact the structure of the city due to their size, nature, or location, which significantly affect the environment, neighborhood, traffic flows, public transport system, and traffic safety. The treatment of major traffic generators is also relevant from the perspective of the development of large-scale parking facilities.

In cases of such developments, a Neighborhood Impact Study (NIS) is often required in many cities (projects subject to a NIS are normally those over 5,000 m²). In summary the NIS normally covers the details of the development (including preliminary plans), the extent of transport in the area e.g. public roads, access routes, assessment of impacts on road/public transport etc, identification of impacts during planning, implementation and operation and also control measures or mitigating impacts to be adopted.

9.7 Traffic Demand Management (TDM)

Traffic Demand Management (TDM) measures are another important consideration. Suggestions for potential TDM options are introduced below for consideration.

The most important short-term TDM measure is the successful implementation of the paid-parking system and the acceptance – by the public – of the controls, payment, and risks of non-payment (including clamping) and a respect of pedestrian zones.

In the medium and long term, traffic management in the Maputo study area could focus on TDM as a tool to curb traffic congestion as this becomes critical to the point of damaging the local economy and the quality of life. Accessibility will be guaranteed for goods and persons through the road system improvements and basic traffic management, such as the CCO traffic signal scheme.

For Greater Maputo some key medium and long-term TDM measures options include, but are not limited to, the following.

a) Better Quality Public Transport: Quality public transport that can offer a viable substitute for the costs of using private cars on the main corridors in terms of travel times, operating costs, and parking costs. This requires mass transit modes equivalent to suburban rail or modern BRT, free from traffic congestion, and thus with faster journey times than cars and with adequate connections. Any system based on the current standard of buses and chapas will not be a suitable alternative.
b) More Short-Term Parking Supply: This implies that the parking system in operation will be rolled out into new districts over time, and thus long-term parking will became scarcer and more expensive and walking times longer. This in turn will put pressure on the city to offer a premium transport service. This is a form of road pricing; the difference is that instead of using expensive technology to charge drivers in movement for using public road space, the charge is made when the car is stopped and using public road space.

c) Controls over road taxes and fines: These controls are based on electronic and police enforcement and use license/number plate reading technology. On-street digital cameras scan all number plates and check on any outstanding road taxes or fines. When coupled with a police checkpoint downstream, the systems allow for only vehicles with large debts to be stopped. This can also permit the use of certain numbers on specific days, e.g., numbers ending in 1 and 2 must not travel within the congested zone on Mondays, 3 and 4 on Tuesdays if required.

d) High-occupancy vehicle (HOV) lanes: Special lanes designated for use by high-occupancy vehicles (usually with three or more people, but in some cases two or more) at certain times of the day (usually during peak periods), could help reduce the total number of vehicles on the roadway and make travel quicker for drivers and passengers in HOVs, encouraging drivers to abandon single cars and use carpools. HOV lanes are difficult to implement and control in developing cities and restrictions on private vehicles tend to be viewed as highly unfair and unpopular.

9.8 Summary and Phasing

Table 9.1 summarizes the main traffic management, control, safety, parking, and TDM measures recommended in the short, medium, and long term. This requires close integration with the public transport and highway phasing.

Table 9.1: Phasing of Traffic Control, Management, and Safety Measures

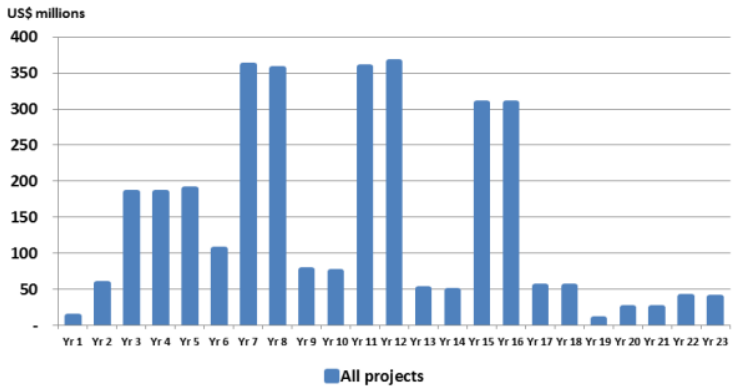
Category	Code	Measure	Short Term	Medium Term	Long Term
Junction Improvements	TM1	Junction Improvements	✓		
Short-Term Traffic Management Measures	TM2	Short-term Public Transport Priority/Improvements	✓		
	TM3	Improved Access to New Suburbs ("Bairros Populares") along the Main Highways	✓		
	TM4	Short-term Road Development and Urban Structuring Measures	✓		
	TM5	Links Connecting New Projects with the Existing Road Network	✓		
Traffic Signal Measures	TM6	Warrants for Signals	✓		
	TM7	Package of Conflicting Right-turn Schemes	✓		
	TM8	Area Traffic Signal Control System	✓	✓	
	TM9	Medium-term Traffic Signal Expansion	✓	✓	
	TM10	Bilateral Agreements on Maintenance/ Timings	✓		
Traffic Accident and Road Safety Measures	TM11	Digital Database	✓		
	TM12	Pedestrian Measures at Accident Hotspots	✓		
	TM13	Alcohol-Related Measures	✓		
	TM14	Better Driver Training and Education	✓		
	TM15	Greater Control of the Fleet	✓	✓	
	TM16	Electronic Enforcement		✓	
Parking	TM17	Expansion of the Rotativo System	✓	✓	
	TM18	Special Access and Other Reserved Bays	✓	✓	
	TM19	Sidewalk Parking	✓	✓	
	TM20	Regulation on Parking and Land Use	✓	✓	
Traffic Demand Management (TDM)	TM21	Range of measures and policies put forward to be considered		✓	✓

Source: JICA Project Team

Chapter 10 Implementation and Financing Strategies

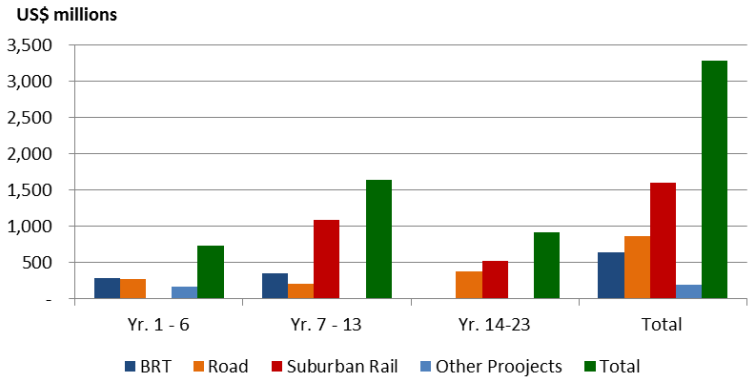
10.1 Introduction

Total expenditures for the investment projects included in the Master Plan are estimated at USD 3.3 billion (MT 100.1 billion) over 23 years (2013–2035).[1] Approximately 72% of project expenditures occur in the first ten years (2013–2022). The BRT, road, and suburban rail investments account for about 94% of total expenditures. Figure 10.1 summarizes Master Plan project expenditures, while Figure 10.2 presents project details.



Source: JICA Project Team

Figure 10.1: Master Plan Project Expenditures



Source: JICA Project Team

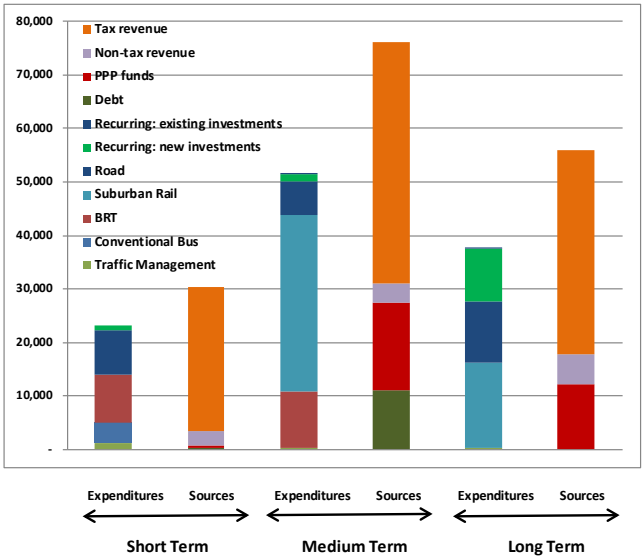
Figure 10.2: Master Plan Project Details

Based on assumptions for growth in Mozambique's gross domestic product (GDP), inflation, and funding available to greater Maputo through local budgets and central government transfers, it is estimated that external debt funding required over the 23 years of the Master Plan will be approximately USD 372 million (MT 11.4 billion).[2] External debt outstanding will reach its highest level, USD 372 million, in year 8 (2020). This estimate is based on limiting external funds accessed for the project to approximately 1.5% of Mozambique's projected GDP.

This approach and the assumption that the proposed Master Plan projects will be fully funded according to the proposed plan results in central government transfers to Greater Maputo

[1] All values are stated in constant 2012/2013 prices.
[2] An additional USD 955 million is assumed to be raised through PPP projects.

exceeding 0.50% of GDP, the highest level, in year 11 (2023, 0.53%) and year 12 (2024, 0.52%).[3] Figure 10.3 summarizes the Master Plan financing.



Source: JICA Project Team

Figure 10.3: Master Plan Financing Plan Summary[4]

10.2 List of Master Plan Projects

Table 10.1 summarizes the Master Plan capital projects.

Table 10.1: Master Plan Projects

No.	Transport Projects	Description	Timing[a]	Estimated Cost (millions)
1.	Highway/Road (8 projects)	New construction of ring roads, arterial roads and connector roads, widening of and improvements to existing roads	Years 2–23	MT 26,130/ USD 857
2.	Suburban Rail (3 projects)	Double tracking of high volume areas in central Maputo vicinity, depot construction, rolling stock investments	Years 7–16	MT 48,939/ USD 1,605
3.	Bus Rapid Transit (three phases)	Network optimization, vehicle and infrastructure investment, capacity building, ITS, management systems	Years 3–13	MT 19,296/ USD 633
4.	Conventional Bus (5 projects)	Capacity building, network design, fleet and infrastructure, industry restructuring	Years 1–5	MT 3,984/ USD 131
5.	Traffic Management (14 projects)	Traffic flow improvements (one-way reversible, bus only, HOV), adaptive signal control systems, traffic control and accident database software, enforcement programs, training	Years 1–23	MT 1,786/ USD 58
	Total			MT 100,134/ USD 3,283

Abbreviations: HOV = high-occupancy vehicle, ITS = intelligent transport system(s)
Note: [a] Assumes 1 April 2013 commencement.
Source: JICA Project Team

[3] Does not include external debt.
[4] Short term is years 1–6, Medium Term is years 7–13 and Long Term is years 14–23.

10.3 Implementation Schedule

Table 10.2 and Table 10.3 set out the expenditure schedule for each project type.

Table 10.2: Master Plan Projects Expenditure Schedule by Year

Units: USD million

Project Type	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Years 6–10	Years 11–23	Total
Road	--	31.4	87.8	67.1	59.5	131.8	479.1	856.7
Suburban Rail	--	--	--	--	--	503.8	1,100.8	1,604.6
BRT	--	--	58.9	73.4	87.4	325.2	87.8	632.7
Conventional Bus	6.7	20.4	30.9	37.1	35.4	0.2	--	130.6
Traffic Management	5.8	5.8	6.6	6.2	6.2	12.6	15.3	58.5
Total	**12.5**	**57.6**	**184.2**	**183.8**	**188.5**	**973.6**	**1,682.9**	**3,283.1**

Source: JICA Project Team

Table 10.3: Master Plan Expenditure Schedule, Short, Medium, and Long Term

Sector	Short Term			Mid Term			Long Term			Total		
	USD Mil	MT Bil	%	USD Mil	MT Bil	%	USD Mil	MT Bil	%	USD Mil	MT Bil	%
Conventional Bus	131	4.0	17.9	–	–	–	–	–	–	131	4.0	4.0
BRT	289	8.8	39.5	344	10.5	20.9	–	–	–	633	19.3	19.3
Road	275	8.4	37.6	206	6.3	12.5	376	11.5	41.4	857	26.1	26.1
Suburban Rail	–	–	–	1,083	33.0	66.0	522	15.9	57.3	1,605	48.9	48.9
Traffic Management	37	1.1	5.1	9	0.3	0.6	12	0.4	1.3	59	1.8	1.8
Total	732	22.3	100	1,642	50.1	100	910	27.7	100	3,283	100.1	100

Source: JICA Project Team

10.4 Summary Cash Flow by Year

Table 10.4 indicates annual cash flow by major item for each of the first five years and for years 6 to 10 and years 11 to 23 (the Master Plan horizon).

Table 10.4: Master Plan Annual Cash Flow Summary

Units: USD million

Item	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Years 6–10	Years 11–23	Total
Project Expenditures	(12.5)	(57.6)	(184.2)	(183.8)	(188.5)	(973.6)	(1,682.9)	(3,283.1)
TPM Operating Cash Flow	2.0	2.1	2.4	2.7	3.3	16.2	40.4	69.1
BRT Operating Cash Flow	--	--	--	--	--	4.2	12.1	16.4
Road Maintenance	(8.4)	(8.6)	(8.7)	(8.9)	(9.1)	(48.0)	(139.6)	(231.4)
Suburban Rail Operating Cash Flow	--	--	--	--	--	0.4	(269.3)	(268.9)
Municipal Expenses	(23.8)	(23.8)	(23.8)	(23.8)	(23.8)	(118.9)	(309.2)	(547.1)
Financing Plan[a]	42.7	87.8	214.3	213.8	218.1	1,119.9	2,348.4	4,245.0
Total	**$ --**	**$ --**	**$ --**	**$ --**	**$ --**	**$ --**	**$ --**	**$ --**

Abbreviations: BRT = bus rapid transit, PPP = public-private partnership, TPM = Transporte de Moçambique

Note: [a] Includes net PPP capital funding of USD 243.3 million over the term of the Master Plan for BRT and Suburban Rail (funds received minus support payments), and interest payments and loan repayments of USD 252.1 million

Source: JICA Project Team

Master Plan cash flow estimates include increasing profits for Transporte de Moçambique (TPM, the Maputo public bus company) as conventional bus projects improve TPM results. BRT and Suburban Rail were modeled as public-private partnership (PPP) projects. The operating cash flow presented in Table 10.4 for BRT and Suburban Rail combined is negative USD 252.5 million. This is for maintenance capital expenditures during the Master Plan period that will be funded by the public sector. The PPP projects will generate approximately USD 955.4 million in capital funding, which are included in the Financing Plan amounts in Table 10.4. Details of these projects and the PPP financing strategy are discussed in Technical Report H. Road maintenance and municipal operating expenses (mostly salaries and wages) account for the balance of the projected cash expenditures. The financing plan was modeled to result in a breakeven annual cash flow in accordance with Greater Maputo budget policies.

10.5 Budgetary Framework for the Master Plan

Table 10.5 states the significant assumptions made for development of the Master Plan financial projections. Table 10.6 and Figure 10.4 present the Master Plan budget.

Table 10.5: Significant Assumptions Supporting the Master Plan

Item	Assumption/Source
Real GDP	2013 – MT 449 billion will increase by an average 5.6% per year over the plan horizon, and 7.5% per year over the first 10 years. Sources: 2013–2017 (Yrs. 1–5), IMF 5th Review Under Policy Support, 3 January 2013; 2018–2035 (Yrs. 6–35), JICA Project Team
Real GDP growth	Will ranges from 2.1% to 8.4%, averages 5.6% per year over the first 10 years and 7.5% over the planning horizon. Sources: 2013–2017 (Yrs. 1–5), IMF 5th Review Under Policy Support, 3 January 2013; 2018–2035 (Yrs. 6–35), JICA Project Team
Inflation	Consumer Price Index, will range from 3.9% to 7.0%, averages 4.9% per year over the planning horizon and 5.7% over the first 10 years. Note that the estimates included are in constant prices and inflation does not affect the estimates. Sources: 2013–2017 (Yrs. 1–5), IMF 5th Review Under Policy Support, 3 January 2013; 2018–2035 (Yrs. 6–35), JICA Project Team
Basis of funding program forecasts	Primarily percentage of GDP using historical averages for individual programs as the basis of the projection. In addition, certain funding programs were used to balance funding with requirements represented by the Master Plan Projects and budgetary expenses; the sources of historical figures for the funding sources were various Maputo and Government of Mozambique agencies. The JICA Project Team was the source for projected funding levels.
TPM	TPM's projected operating income was based on historical results for passengers, revenue, and individual expense line items provided by TPM and the Ministry of Finance. TPM also provided projections through 2016 of passengers, passenger revenue, other revenue items, and certain expenses. The JICA Project Team was the source for the projected revenue, operating expense and maintenance capital expenditures were based on the analysis done to develop the Conventional Bus Project plans, a review of the conventional bus infrastructure, and discussions with TPM managers and other local officials, and the JICA Project Team's previous experience.
BRT	BRT projections for passengers, revenue, expenses and capital expenditures were based on JICA Project Team assumptions developed from the analysis undertaken to develop the BRT project plans, review of the road infrastructure, discussions with local officials, and previous experience.

Item	Assumption/Source
Suburban Rail	Suburban Rail projections were based on historical information received from CFM and JICA Project Team assumptions based on analysis undertaken to develop the Suburban Rail Project plans, previous experience, a review of CFM's infrastructure, and discussions with CFM officials.
Road Maintenance	Road maintenance expense and capital expenditure forecasts were based on historical information received from the Maputo Municipal Infrastructure Department, the Matola Municipal Infrastructure Department, the Marracuene Municipal Infrastructure Department, and ANE (for Boane). The JICA Project Team assumptions were based on analysis to develop the Road Project plans, a review of the road infrastructure, discussions with local officials, and previous experience.
PPP Projects	PPP projects were assumed for BRT and Suburban Rail. The amount of private sector investment and necessary government support was based on an assumed return requirement for private sector investors of 13% (weighted average pre-tax return based on assumed percentages of debt and equity in capital structure).

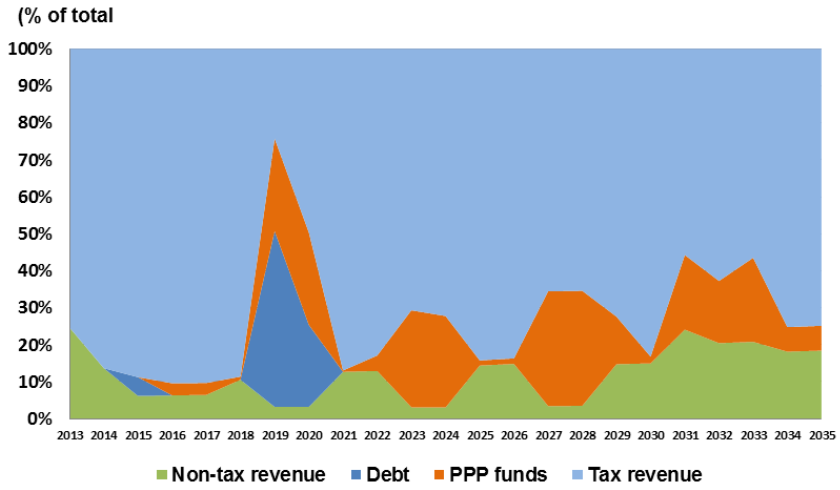
Abbreviations: ANE = Administração Nacional de Estradas (National Road Administration), BRT = bus rapid transit, CFM = Portos e Caminhos de Ferro de Moçambique (Mozambique Ports and Railways), GDP = gross domestic product, IMF = International Monetary Fund, JICA = Japan International Cooperation Agency, TPM = Transporte de Moçambique
Source: JICA Project Team

Table 10.6: Master Plan Budgetary Framework

Units: USD million

Component	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Years 6–10	Years 11–23	Total
MTFF	5.3	5.9	16.2	6.1	6.6	40.8	167.8	248.7
Road Fund	1.8	2.0	2.1	2.3	2.5	15.5	63.6	89.8
FCA	4.9	11.1	27.4	27.7	28.2	94.8	263.2	457.4
FIA	2.4	5.5	13.6	13.8	14.0	47.1	130.7	227.1
FDD	6.8	15.4	38.0	38.4	39.1	131.3	364.9	634.0
Parking/Vehicle Fees	0.8	0.9	1.0	0.8	0.9	5.3	21.9	31.6
Other Local Funds	20.6	47.0	116.0	117.4	119.5	401.0	1,113.9	1,935.3
TPM Subsidy	--	--	--	--	--	--	--	--
Rail Subsidy	--	--	--	--	--	--	269.3	269.3
External Funds[a]	--	--	--	7.5	7.5	409.4	179.6	604.0
Total	**42.7**	**87.8**	**214.4**	**214.0**	**218.3**	**1,145.2**	**2,574.7**	**4,497.1**

Abbreviations: FCA = Fundo de Compensação Autárquica, FDD = District Development Fund, FIA = Fundo de Iniciativa Autárquica, MTFF = Medium-Term Fiscal Framework, TPM = Transporte de Moçambique (the Maputo public bus company)
Note: [a] Includes USD 243.3 million net PPP funds for BRT and Suburban Rail; an additional USD 11.6 million of external funding is included, USD 10.6 million in MTFF and USD 1.0 million in the Road Fund. Principal and interest payments totaling USD 252.1 million are excluded from the table.
Source: JICA Project Team



Source: JICA Project Team

Figure 10.4: Master Plan Budget

10.6 Financing Strategies

10.6.1 Elements of an Effective Financing Strategy

An effective financing strategy has the following elements.

a. support for implementation of priority projects on a planned, reasonable schedule
b. utilization of a mix of financing sources to achieve a low effective cost of financing and manage annual cash obligations
c. matching of repayment obligations with assets financed, that is long-term assets are financed with long-term obligations and short-term assets are financed with essentially cash (government budgets)
d. inclusion of procedures to collect and analyze performance data to monitor progress and outcomes and adjust activity as appropriate

Based on these elements and the specific characteristics of Greater Maputo and Mozambique, the recommended financing strategy for the Master Plan is based on the following.

a. Utilize government budgets as the primary source of funds. Strong GDP growth for Greater Maputo and Mozambique is expected to continue throughout the Master Plan period.[5] This should have the effect of increasing tax receipts. Mozambique is also pursuing tax reform to improve tax collections which also supports increase in tax receipts. If sufficient tax receipts are available they are better than other options because use of taxes does not create obligations to domestic and international creditors. Improving transportation is a priority for Mozambique and Greater Maputo, and transportation projects generally produce public benefits. Both of these factors make it appropriate to allocate tax resources to the Master Plan. At the same time, investment priorities have to be balanced amongst the various sectors and regions of the economy. The financing plan is structured to remain within what is considered an acceptable allocation of tax resources.

[5] The IMF estimates Real GDP will grow between 7.8% and 8.4% in 2013–2017; IMF 5th Review Under Policy Support, 3 January 2013, Table 1, page 19

b. Minimize the use of private debt. Mozambique's access to the private capital markets is expensive as noted in Table 10.7 below. The financing plan does not include private debt.

c. Control the use of external development agency funds, particularly debt funds. Recent experience suggests it could be more difficult for Mozambique to obtain development funding.[6] Mozambique has plans for significant infrastructure projects in multiple sectors of the economy including transportation. Development financing is often tailored for significant infrastructure projects. Based on this, the financing plan is structured to keep external funds at 1.5% of GDP or below.

d. Investigate private sector participation as a way of extending budgets and also benefiting from capacity building in the form of technology transfer and technical expertise. The financing plan includes Public Private Partnership (PPP) projects for BRT and Suburban Rail.

10.6.2 Potential Sources of Financing

Table 10.7 discusses potential sources of financing that can be considered for the Master Plan projects.

Table 10.7: Potential Sources of Financing

Financing Source	Description	Cost	Pluses/Minuses	Risks
Government budgets	Government annual and long-term capital and operating budgets; funded by various taxes; some specific budgets established for transport; examples of transport-specific capital budgets include the Road Fund at the national level and FIA at the municipal level.[a]	Low direct cash cost; opportunity cost can be high and lead to inadequate available funding	Pluses: low cash cost; social support for social infrastructure; no repayment obligations Minuses: potentially high opportunity cost; subject to competing requirements; availability of funding varies with economic environment	Insufficient funds particularly for multi-year infrastructure projects
Government-issued debt	Government debt issued in public markets to investors, both domestically and in international markets. As of the end of 2012, Mozambique was expected to have approximately USD 6.5 billion of public debt (MT 199 billion).[b]	Mozambique's government borrowing rate as of the end of the third quarter of 2012 was 3.0% for a 90-day Treasury bill.[c] Recent sales of 3-year and 5-year bonds were priced to yield 10% and 17%, respectively.[d]	Pluses: availability of funds, transparent terms and procedures Minuses: high cost, relatively short amortization periods	Refinancing risk because of short amortization periods, effect of high interest rates on budget
Development financing	Single country and multilateral development financing organizations provide grants and loans to support global development; generally sector-specific funds; typically fund 50%–	Loan financing available on extremely attractive terms, including below market interest rates, long amortization periods, grace periods	Pluses: financing terms; lender expertise can benefit project implementation; many organizations have extensive transportation infrastructure lending practices	Passage of time increases project cost; failure to raise matching funds/failure to gain internal approval for loan

[6] Ibid., page 11

Financing Source	Description	Cost	Pluses/Minuses	Risks
	85% of total project cost; usually available for capital items only, expense items not eligible		Minuses: can require substantial matching funds; bureaucratic sometimes lengthy process; lender requirements may be perceived as burdensome	
Public-private partnership	Private sector participation in a public project, ranging from full funding/full risk exposure to partial funding with government support during operating phase	Implementation costs and cash requirements can be significantly improved; subject to terms, private sector returns can increase government cost	Pluses: potentially significant reduction in government cash funding requirement at implementation; can be tailored to specific projects and government desires Minuses: private sector return requirement can increase cost; public/private dynamic can be complicated	Private sector performance if return does not materialize; litigation; general public's concern with private ownership of public assets
Transit oriented development	Real estate and commercial development initiatives along a transit corridor that take advantage of the increase in value that typically occurs when transit projects are implemented	From no direct cost to expenditure to prepare areas for development	Pluses: Can be minimal cost to government; opportunity to involve private sector to generate revenue in addition to farebox; potential to increase traffic at stations and transit ridership Minuses: may require law/regulation revisions, sometimes complex contracts required, general public concerns with private operator/ownership	Opportunity cost, avoiding pricing too low but still gaining interest; potential litigation to regain control if private sector fails

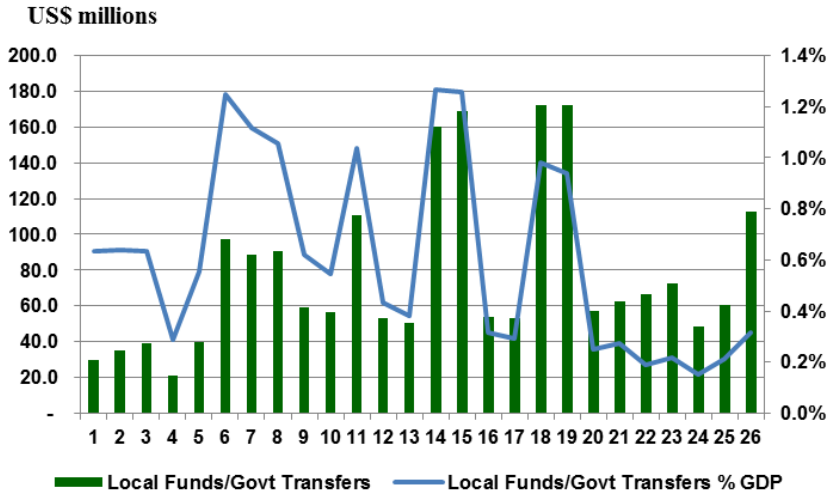
Notes: [a] *Fundo de Iniciativa Autárquica (FIA)* funded by transfers from the central government. [b] Calculated from IMF figures: Fifth Review under Policy Support Instrument, 3 January 2013, Table 1, p. 19. [c] See source in previous note, Table 4, p. 22. [d] Reuters, 22 August 2012, http://www.reuters.com/article/2012/08/22/mozambique-bond-idAFL6E8JM5IJ20120822
Source: JICA Project Team

Each of the financing strategies noted above is discussed in more detail in the following sections.

10.6.3 Government Budgets

Government budgets funded through various Greater Maputo and central government taxes account for approximately 69% of the financing plan. The Master Plan does not assume any new taxes or revisions to existing programs. The level of funding as a percent of national GDP is illustrated by Figure 10.5.[7]

[7] Constant 2012/2013 prices



Source: JICA Project Team

Figure 10.5: Local and Government Funds Percent of GDP 2010–2035

Figure 10.5 shows local and government transfers used for transportation purposes in Greater Maputo. From 2010 to 2012 this funding was about 0.6% of national GDP. During the Master Plan period funding is estimated to average 0.6% of GDP and a maximum of 1.25%–1.27% during years of high investment activity. As Mozambique's GDP grows and the projects are completed, funding as a percent of GDP is expected to be less than 0.3%.

The IMF has estimated Mozambique's government revenues for 2013–2017 in a range of 23.1% to 25.4% of GDP.[8] The estimated funding for the Master Plan at its highest is approximately 5% of this level. With the importance of improving public transport in Maputo City and Greater Maputo allocating the projected amount of Mozambique's tax revenues to solve transportation issues in Maputo should be achievable.

10.6.4 External Funds

External funds would be a mix of grants and loans from development financing agencies like the IMF, World Bank, African Development Bank and JICA. In addition Mozambique does issue debt both domestically and in international capital markets. As noted in Table 10.7, Mozambique's access to private capital markets is relatively expensive particularly for longer terms.

This points to use of development financing for the bulk of external funding. The proposed financing plan assumes that all external funds are "concessional" loans from development agencies (2.0% interest rate, 5 year grace period on principal repayment and 35 year amortization). This is a conservative view as it is likely that some portion of development financing will be available as grants. External funds outstanding were intentionally kept at a maximum of approximately 1.5% of GDP. This reflects the expectation that obtaining financing could be more difficult in the coming years and the need to reserve capacity for other sectors of the economy. Specifically, the 1.5% is based on the IMF's estimate that non-budget resources for financing Mozambique's public investment program will range in total from 13.3% to 14.7% of GDP between 2013 and 2016. This includes donor financing (grants and concessional loans) between 4.4% and 6.2% of GDP over the period.[9]

[8] IMF 5th Review Under Policy Support, 3 January 2013, Table 1, page 19
[9] IMF 5th Review Under Policy Support, 3 January 2013, Table 1, page 12

10.6.5 Public Private Partnerships

Public Private Partnerships (PPP) have been implemented in a number of public infrastructure projects throughout the world. The N4 Toll Road is a PPP. PPP arrangements rely on the expectation that a public transport infrastructure project has the potential to generate financial returns acceptable to private sector entities. To increase potential returns, PPP arrangements often include TOD rights for the private sector investors. Two basic PPP models have been applied to infrastructure assets:

a. Build Operate Transfer (BOT) – this approach has the private sector funding the construction, operation and maintenance of the infrastructure asset under a long-term contract (Concession), generally between 30 and 50 years. At the end of the Concession, the asset is transferred to government ownership.
b. Build Transfer Operate (BTO) – the private sector finances and builds the asset and transfers it to the public sector at completion of construction. This structure enables the public sector to benefit from private sector management of the construction and take immediate ownership of an essential public asset. The private sector operates the asset on a long-term basis under terms essentially the same as a BOT. A BTO may also be useful for addressing legal restrictions on private sector ownership of public infrastructure.
c. Often in PPP arrangements for large infrastructure projects the public and private sectors share project financing. This approach is used when it does not appear likely that private sector returns can be achieved on the full cost of the project. This allows the public sector to benefit from risk transfer, the private sector's efficient management practices, technical and expertise transfer, as well as some amount of private sector project financing. An example is the Bangkok metro:
    - The Bangkok metro is a 27 km underground system that started revenue operation in 2004.
    - The private sector company is Bangkok Metro Public Company, Ltd. (BMCL). The Thai government owns 25% of BMCL.
    - The cost of the tunnels, stations, tracks and other fixed infrastructure, approximately 83% of the project cost, was financed by the Thai government.
    - BMCL financed rolling stock, signaling systems and other operational assets.
    - BMCL operates and maintains the metro (including the infrastructure financed by the government) and retains profits (and losses) from the operation under a 25-year Concession.
    - Under the Concession, BMCL pays to the government a portion of its annual revenue.
    - BMCL has a 10-year contract with Siemens to maintain rolling stock and systems. Siemens also supplied the rolling stock under this contract.
    - At the end of the Concession, the assets financed by BMCL will be transferred to the government.
    - BMCL is profitable and does not receive a subsidy from the government.
    - The Japan Bank for International Cooperation (JBIC) provided loan financing to the Thai government for about 90% of the civil and infrastructure construction.

Another method to involve the private sector is operating and maintenance contracts. Under these contracts the private sector is engaged on a contract basis to perform certain services. Train operations, rolling stock maintenance and infrastructure maintenance are the usual

services and an individual contract can include one service or multiple services. As noted, BMCL has a contract with Siemens for maintenance of rolling stock and systems. Contracts usually are structured as a fixed fee for the service provided with the fee established each year through an annual budgeting process. Incentives are often included to motivate the private party to provide excellent service and find ways to operate at lower cost. These contracts, sometimes called "Service Concessions", are generally for a shorter term than a PPP Concession, in the range of 10–15 years. This is because the private operator does not have investment capital at risk.

The Bangkok metro model is a potential model for the Suburban Rail and BRT Master Plan projects. Both projects have "fixed" assets and "operational assets." The railroad's fixed assets include track, right of way and stations and its operational assets include train coaches, signal systems and train control systems. The BRT's fixed assets include the road surface and stations and its operational assets include primarily buses.

10.6.6 Transit Oriented Development

Transit oriented development (TOD) is a potential supplement to a base financing plan for public transportation infrastructure. The TOD opportunity is created by the increase in real estate and commercial value that has been shown to accompany establishment of a transit corridor or rehabilitation of an existing corridor. TOD is particularly effective along transit rail corridors and could be an opportunity to lower the financial burden of establishing the proposed commuter rail service.

a. To capture a portion of this value for the transit corridor owner and/or operator, often referred to as "value capture", TOD develops residential, commercial and institutional facilities along a transit corridor. This activity also creates public benefits by fostering more compact, livable communities.
b. Financial benefits for the transit owner and/or operator can include financing support for project implementation. This is accomplished by granting development rights to private sector entities in return for funding transit infrastructure such as rail stations, station parking lots, and access roads.
c. Financial benefits can also include an on-going revenue source through recurring payments from the private sector entities in the form of concession fees, lease payments or royalties.
d. Public benefits arise from the fundamental attraction of a transit corridor. By placing residential, commercial and institutional facilities on the transit corridor, TOD fosters livable communities that minimize the need for personal automobile transportation, encourage local commercial activity, and enhance the environment by shifting transportation from private automobiles to public transportation.
e. There are several approaches to value capture with TOD:
    - Land development – private sector entities are given rights to produce income by developing land along the corridor. Value capture would be in the form of agreement by the developer to finance the construction of transit stations and other transit infrastructure, a royalty type arrangement in which the developer pays a portion of revenue to the transit operator, or lease of occupancy to a third party for a stated period. Often the arrangements include upfront financing and on-going payments. If the public sector has access to development financing through organizations such as the Japan International Cooperation Agency and the African Development Bank, pushing more of the value to on-going payments could lower the overall cost of the project by taking advantage of the attractive terms of development financing in comparison with private sector financing. This in turn

would extend the amount the private sector can invest and still achieve an acceptable financial return. This should be balanced with consideration of the total amount of debt raised by the public sector for a project.

- Tax increment financing – the concept of tax increment financing (TIF) is the location (or rejuvenation) of a transit operation often increases the value of real estate and existing commercial properties along a corridor resulting in an increase in future property taxes. The increase is referred to as the "tax increment." The TIF structure allocates the tax increment to secure debt financing for the project. TIF requires specific legislation to establish the TIF mechanism and possibly to permit use of property taxes to repay debt.
- Special tax districts – the transit corridor, or a portion of the corridor, could have a new, temporary tax levy (or addition to an existing tax) to contribute to financing the construction of the transit infrastructure. Alternatively, a portion of an existing tax could be allocated to this purpose.
- Lease of commercial and retail space inside the stations to private retail and commercial businesses.

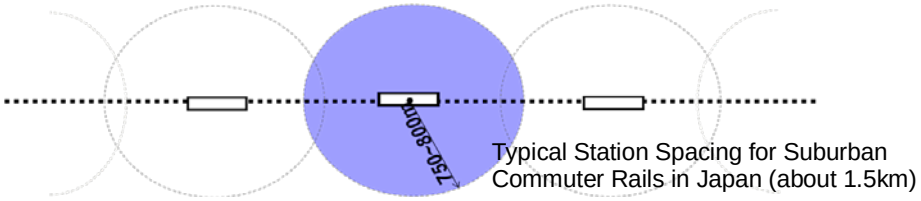
In Japan, for example, TOD has been employed extensively as an instrument to finance (partly) the development of mass transit and create an efficient form of urban structure. Key principles of TOD based on experiences in Japan are described in the box below. (See Technical Report P for more details of the Japanese experience with TOD.)

TOD involves actions that could require legislative and regulatory action. Real estate laws are somewhat specific to location and in order to use the land to generate income changes may be necessary. For this reason, as well as the overall effort required to implement a TOD project, analysis of potential sites should be implemented early on.

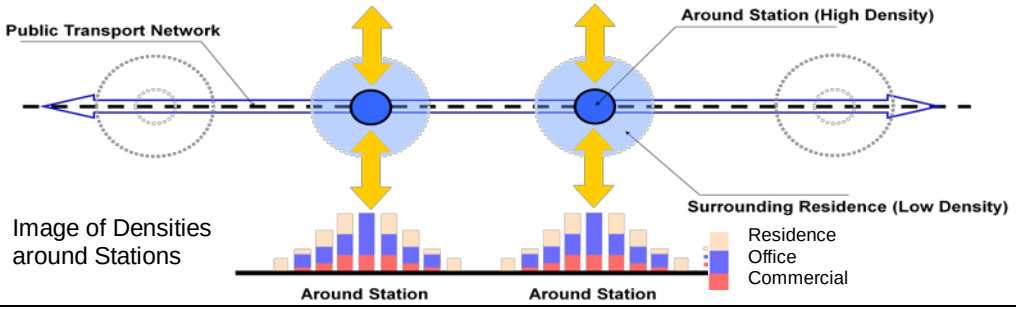
Box 10.1: Key Principles of TOD in Japan

Key guiding principles of TOD based on Japanese experiences are as follows:

i) Set station spacing about twice walking distance (usually 750–800 m).

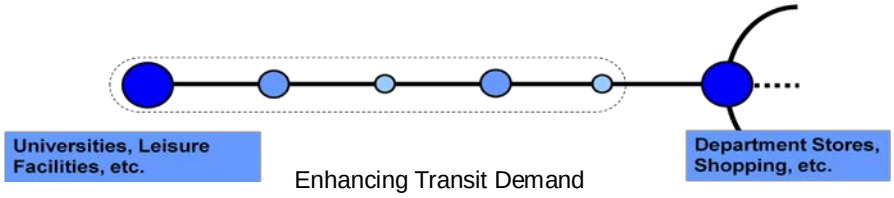


ii) Locate high density office buildings, retail outlets and residential properties right around the stations. Locate lower density facilities and residential properties slightly further away.



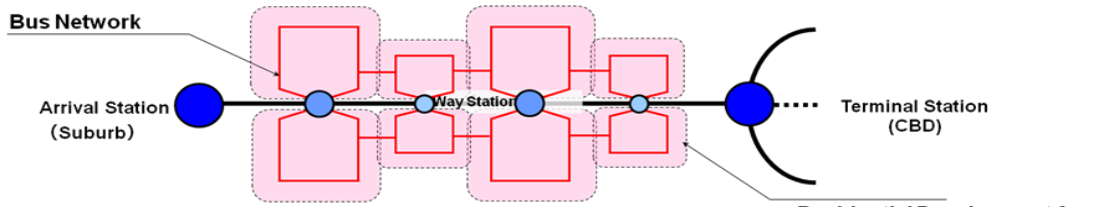
iii) Create an attractive environment at the stations with food and retail outlets to build passenger traffic and an area that will be visited by the community.

iv) Induce development at terminal stations as well as the stations along the line to enhance ridership of the mass transit.



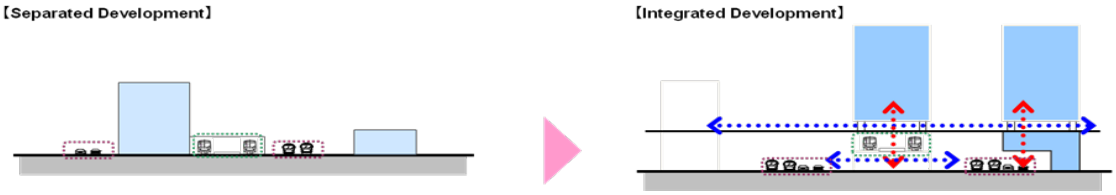
Enhancing Transit Demand

v) Expand development areas with use of a bus network.



Reach of Bus Network along the Transit Line

vi) Undertake integrated development of railway stations, stops of different transport modes, and commercial buildings, thereby allowing for easy transfer between modes as well as enhancing commercial activities.



Integrated Development of Stations, Stops of Different Modes, and Commercial Buildings

Source: JICA Project Team

(1) TOD Potential in Greater Maputo

The potential to realize significant TOD activity to support Master Plan implementation in Greater Maputo depends on the following key factors:

a. Access to development sites

- Number and location of sites;
- Coordination with existing land use and development programs – it is important that land planning initiatives take into account the TOD opportunity and plan for its implementation as appropriate;
- Negotiation with land owners – whether directly with the state or with parties holding DUAT rights, negotiations for access to the land and authorization to implement TOD are of course essential.

b. Investor interest

- Demonstrating potential returns – reasonable estimates of income potential, available incentives (i.e., financial support, tax benefits);

- Risk sharing – clear demarcation of responsibilities and obligations, willingness to share specific risks.

c. Capturing the value
   - Determining the best approach for each site – third party development, Concession agreements, PPP, direct development.

d. Financing
   - Developer financing, PPP, special tax districts, general budget.

e. Legal and regulatory requirements:
   - Identifying needed modifications and ensuring they are made.

A TOD plan for Greater Maputo will need to address all these issues to determine the scale of the opportunity and how best to implement TOD successfully. A recommended first step is making an inventory of all potential development sites along the proposed transportation corridors and evaluating them as future TOD sites. This will require a description of the different types of TOD projects: creating essentially new communities, enhancing retail and commercial activity in the transit corridor area, improving integration with other transportation modes, etc.

Based on the completed inventory, a formal feasibility study of one or two potential TOD sites is recommended to further investigate TOD's potential.

10.7 Monitoring and Project Management

It is recommended that a project performance monitoring system (PPMS) be developed for the overall Master Plan and for each Master Plan project. The PPMS should include indicators that are relevant to performance but can be monitored with reasonable effort. The objective is to generate data systematically on project outcomes, inputs, outputs, and indicators of performance.

At the commencement of project implementation, the Executing Agency (EA) should develop a PPMS for the entire Master Plan and the Implementing Agencies (IAs) should develop systems for individual projects. At the Master Plan level, performance indicators could include: (i) overall spending versus project budgets; (ii) adherence to schedules; (iii) increased use of public transport/decreased use of private transport; and (iv) improvement in environmental quality. Project level indicators could include: (i) execution versus budget and schedule; (ii) number and value of claims against contractor performance; (iii) operating performance versus expectations–patronage, fares and revenue, operating expense, financing obligations; (iv) required subsidies and other government support; and (v) community satisfaction with the project.

The PPMS should be continually refined to reestablish baseline performance, confirm achievable targets, and improve monitoring and recording arrangements. Table 10.8 is an example of a PPMS matrix that could apply to the Master Plan.

Table 10.8: Tentative Monitoring and Evaluation Framework

Design Summary	Performance Targets/ Indicators	Data Sources/ Reporting Mechanisms	Assumptions/ Risks
Impact	**By 2020**		**Assumptions**
Safe, efficient, and more environmentally sustainable urban transport system is established	Increase in number of public transport passengers per annum versus 2012 (from xx million to yy million)	Bus/BRT/Rail operator annual statistics	Construction of the Bus, BRT, and Rail projects completed on schedule. Target performance based on final agreed project plans.
Improved mobility conditions in Greater Maputo	Improved road conditions	DMI surveys, inspections of roads	DMI procedures for monitoring road condition in place.
	Increased use of public transport	Bus/BRT/Rail operator annual statistics	Construction of the Bus, BRT, and Rail projects completed on schedule.
Outcome	**By 2020**		**Assumptions**
Expanded and upgraded urban transport infrastructure, and urban environment that will help Greater Maputo meet its urban expansion needs up to 2035.	Efficient access to bus, BRT, and rail transit	Public transport user interview surveys	The traffic growth forecasts for Master Plan projects are achievable and reasonably accurate.
		Public transport operator annual passenger statistics	
		Road user interview surveys	
	Increased bus traffic speeds by x%. Increased share of travel by public transport from x% in 2012 to y% in 2020.	Field observation	
		Bus operators annual statistics	Construction of the Bus and BRT projects completed on schedule.
	Highway trip times reduced by 2020 versus 2010	Field observation	Master Plan projects completed on schedule.
	Motor vehicle related carbon dioxide emissions reduced from xx to yy tons per annum.	Annual environmental monitoring report of Maputo. National Environmental Protection Bureau.	Master Plan projects completed on schedule.
Outputs	**By 2020**		**Assumptions**
Purchase of new buses to renew conventional bus fleet	Delivery and operation of 750 new buses	FEMATRO, TPM, Ministry of Finance records	Availability of appropriate equipment
Construction of new BRT infrastructure, purchase of BRT vehicles	Phase I of the BRT Master Plan open and operating	BRT operator records and interviews	Availability of funds
		BRT customer interview	Availability of appropriate equipment
Operations begin on Maputo – Matola Gare commuter rail	Track and infrastructure in place, rolling stock procured, commissioning completed, passengers using the service	Rail operator records and interviews	Availability of funds
		Rail customer interviews	Availability of appropriate equipment
National and Other Arterial Road project completed	Road construction completed and roads open for traffic	DMI/DMTT records and interviews	Availability of funds
		Surveys of highway users	Availability of funds

Abbreviations: BRT = bus rapid transit, DMI = Direcção Municipal de Infra-Estruturas (Directorate of Municipal Infrastructure), DMTT = Direcção de Serviço Municipal de Transportes e Trânsito (Directorate of Municipal Transport and Traffic), FEMATRO = Federação Mmoçambicana dos Transportadores Rodoviários (Association of Road Transport Operators), TPM = Transporte de Moçambique
Source: JICA Project Team

In Chapter 12 of this report, the establishment of a Greater Maputo Metropolitan Transport Agency (GMMTA) is proposed, and once established, the GMMTA should perform the above-mentioned monitoring and project management activities. As recommended in Section 12.3 of Chapter 12, the proposed GMMTA should serve as the EA for the overall Master Plan, and IAs should be designated to be responsible for individual Master Plan projects. Essentially, the organizational structure proposed in Section 12.3 can be employed for the development and implementation of a PPMS for the entire Master Plan and for individual projects.

10.8 Financial Risk Assessment

There are several risks to achieving the financing plan for the Master Plan projects:

10.8.1 Cost Escalation/Cost Overruns

Cost escalation due to unexpected delays in executing the project, inaccurate budgets, or poor project execution would increase cost above budgeted amounts.[10] A 1.0% increase in annual cost during each year of the Master Plan would increase total project spending by approximately USD 33 million.

10.8.2 Lack of Demand

Lack of demand for Conventional Bus, BRT, and Suburban Rail services would reduce passenger revenue and reduce the contribution of these services to the financial plan or increase the subsidy necessary to maintain the operations (excluding the effects of cost reduction efforts). Table 10.9 presents the impact of demand shortfalls on each of these services.

Table 10.9: Impact of Demand Shortfalls on Conventional Bus, BRT, and Suburban Rail Services

Service	Change in Demand	Impact on Revenue/Subsidy
Conventional Bus	Minus 1% each year	USD 40 million
BRT	Minus 1%	USD 243 million
Suburban Rail	Minus 1%	USD 23 million

Source: JICA Project Team

10.8.3 Shortage of Funding

Funding shortages can be caused by a number of factors, including those listed below.

- Decline in economic activity
- Inability to implement planned tax initiatives
- Failure to collect taxes
- Lack of access to development financing or development financing at lower levels than expected
- Lack of interest from private sector investors (if PPP-type arrangements are part of the financing plan)

Most of the funding programs were projected based on a percentage of GDP. The impact of a funding shortage is estimated based on a 1% decrease in projected GDP levels, which throughout the Master Plan period would reduce funding by approximately USD 40 million.

[10] The Master Plan financing plan is stated in constant 2012/2013 prices.

Chapter 11 Economic, Social, and Environmental Evaluation

11.1 Introduction

This chapter describes the economic, social and environmental evaluations undertaken, and contains the following topics.

- Brief outline of the methodology adopted
- Derivation of parameters used to interpret transport model outputs
- Project costs incorporated into the economic analysis
- Economic evaluation results
- Potential social and environmental mitigation measures

11.2 Methodology and Evaluation Cases

As stated in Chapter 6, the preferred scenario carried forward for economic evaluation was Land Use Scenario C and Transport Network C. This is the "Do Maximum" scenario and is compared against the "Do Minimum" scenario, which comprises current conditions with only committed transport network improvements. In contrast, "Do Maximum" comprises a range of bus, BRT, rail, road and traffic management schemes.

The outline methodology can be described as follows:

1) Based upon transport model outputs and parameters for economic evaluation (Section 11.3), benefit streams are calculated for 2035 and estimated by year
2) Cost streams are also calculated by year
3) Based upon capital expenditure the proportion of benefits from 1) applying in each year are calculated
4) The resultant cost and benefit streams are then combined in order to perform Discounted Cash flow Analysis (DCF) to derive scheme Net Present Value (NPV) at a variety of discount rates, the Economic Internal Rate of Return (EIRR) and Payback Period.

11.3 Parameters for Interpretation of Transport Model Outputs

11.3.1 Value of Time

The Value of Time (VOT) was estimated based upon the following.

- Per capita GDP in the Study Area
- Price inflation to 2012
- Growth estimated in GDP per capita
- Data from the Household Interview Survey (HIS)

As per materials presented at the 3rd Steering Committee, based upon data from INE and projections made by the JICA Project Team, per capita GDP in Maputo City and Maputo Province was as shown in Table 11.1, in 2009 prices. Given that Matola, Marracuene and Boane are within Greater Maputo, it was assumed that their income level would be higher. Hence for these areas, GDP per capita was taken to be mid-way between Maputo Province as a whole and Maputo City.

Table 11.1: GDP Per Capita in MT in 2009 Prices

	Year			
Location	**2012**	**2018**	**2025**	**2035**
Maputo City	48,062	67,272	95,221	132,346
Maputo Province	28,448	34,671	44,612	55,008
Boane, Matola, Marracuene	38,255	50,972	69,917	93,677

Source: INE, MPD, JICA Project Team

Price inflation estimates from the IMF and the CIA Factbook were used to convert these figures into 2012 prices.

Based upon planning data, 55% of the population in the Study Area lived in Maputo City, with 45% residing in Boane, Matola or Marracuene. According to HIS data, 57% of trips were made by Maputo residents, as opposed to 43% by residents of Boane, Matola and Marracuene. An average of these proportions were used to derive a weighted average GDP per capita, i.e. 56% based upon Maputo City and 44% on the other locations. This then gave GDP per capita estimates for the Study Area as a whole, in 2012 prices, as shown in Table 11.2.

Table 11.2: GDP Per Capita in 2012 Prices for the Study Area as a Whole

	Year			
	2012	**2018**	**2025**	**2035**
GDP per Capita (MT)	61,357	84,267	117,889	161,686

Source: JICA Project Team

It was then assumed that the average work year for Study Area residents was 2,000 hours (equivalent to 50 weeks of 40 hours each). Dividing GDP per capita by 2000 then gave an economic estimate of the value of work-related time (i.e. commutes to or from work, plus trips on employers' business). In line with standard practice, half this value was adopted for non-work trips. According to HIS data, 51% of trips were associated with work. The resultant VOT's adopted by year, in 2012 prices are shown in Table 11.3.

Table 11.3: Value of Time (MT/hour) in 2012 Prices for the Study Area as a Whole

	Year			
	2012	**2018**	**2025**	**2035**
VOT (MT/hour)	23.16	31.81	44.50	61.04

Source: JICA Project Team

11.3.2 Vehicle Operating Costs

Vehicle Operating Costs (VOC) were estimated in the based upon the UK DfT's WebTAG advisory guidance, which covers the build-up of VOC for urban transport models and also upon the WB's HDM model, by vehicle type. Whilst fuller details are set out in Technical Report O, the approach is summarized as follows.

- Take local values for typical vehicle purchase costs (second hand imported cars being more typical than new cars in Maputo, for example), vehicle life, km's operated per year to estimate depreciation; this also taking account of a trend towards smaller-engined cars in Maputo (hence different values for 2012 and 2035)
- Use fuel consumption values for urban transport from WebTAG in the first instance, but then adjust for the roughness of roads in Maputo (using IRI=8 in Do Minimum and IRI=4 in Do Maximum as overall values)

- Input costs of tyres, oil, fuel, maintenance
- For commercial vehicles, estimate crew costs and overheads based upon operating patterns (in the case of buses, separate operating patterns and km operated per year under Do Minimum and Do Maximum)

Equations were defined for each vehicle type in the following form:

$$VOC\ per\ km = A + B.V + C.V^2 + D.V^3 + E/V$$

Where: V= velocity (kph); and,
A, B, C, D and E are parameters

Data were then converted into vehicle categories to match those classes assigned in the transport model, according to surveyed vehicle mix.

Do Minimum VOC's were based upon IRI = 8 and with buses operating according to current practice. Values for A, B, C, D and E are as shown in Table 11.4; whereas Table 11.5 shows Do Maximum VOC's, which assume IRI = 4 and that bus operations are reorganized, in line with recommendations in Chapter 8.

Table 11.4: Do Minimum VOC's (MT per Vehicle-km)

Parameter	Car (2012)	Car (2035)	Truck	Bus	BRT
A	10.2862	9.7789	40.6226	11.5980	n/a
B	−0.2233	−0.2070	−1.0880	−0.1611	n/a
C	0.00258	0.00235	0.01560	0.00154	n/a
D	−0.000009	−0.000008	−0.000068	−0.000006	n/a
E	0.00	0.00	237.20	242.19	n/a

Source: JICA Project Team

Table 11.5: Do Maximum VOC's (MT per Vehicle-km)

Parameter	Car (2012)	Car (2035)	Truck	Bus	BRT
A	9.7244	9.2449	36.1674	16.4108	43.9328
B	−0.2111	−0.1957	−0.9646	−0.3072	−1.0812
C	0.00244	0.00222	0.01383	0.00395	0.01562
D	−0.000008	−0.000007	−0.000061	−0.000017	−0.000069
E	0.00	0.00	231.47	257.42	393.31

Source: JICA Project Team

The higher per vehicle-km operating costs for bus in the Do Maximum case are due to larger vehicles being used on average, with higher passenger occupancies (see Section 11.3.4). In passenger-km terms, bus VOC would be lower in Do Maximum than Do Minimum.

11.3.3 Emissions

Emissions of CO_2 and NO_x were estimated on a per vehicle km basis according to speed, using an equation form similar to that used for VOC, though without the *"E"* term. Parameters from the Japanese Ministry of Land and Transport were adopted, with relationships specified for small vehicles (i.e. car) and large vehicles (truck, bus, BRT). The A, B, C and D parameters are shown in Table 11.6.

Table 11.6: CO_2 and NO_x Emissions by Vehicle-km according to Speed

	Grams of Carbon per vehicle-km		Grams of NOx per vehicle-km	
Parameter	**Small Vehicles**	**Large Vehicles**	**Small Vehicles**	**Large Vehicles**
A	1.377142857	3.025714286	0.004435714	0.042357143
B	−0.047454185	−0.078176768	−0.000113286	−0.000401151
C	0.000768182	0.001108009	1.65584E-06	−4.42857E-06
D	−4.11616E-06	−5.05051E-06	−6.31313E-09	8.05556E-08

Source: Japanese Ministry of Transport

Both CO_2 and NO_x figures are used in the environmental assessment. For the economic assessment, the cost of carbon emissions are monetized on the basis of USD 5.20 per metric tonne of CO_2 in 2012 (equivalent to recent prices on European exchanges), increasing to USD 23.00 per metric tonne of CO_2 in 2035 (equal to the all-time high on the European exchanges for emissions trading).

11.3.4 PCU Factors and Vehicle Occupancies

The transport model assumed passenger car unit (PCU) equivalent factors of 1.0 for cars, 2.0 for bus (incorporating large buses and various sizes of minibus and chapas) and 2.5 for trucks.

Whilst the model assumed a certain set of vehicle occupancies for purposes of assignment, the economic analysis revised these, based upon existing occupancy factors. These were based upon existing occupancy factors for chapas, minibus and bus as determined during transport surveys (77%, 77% and 97% of seating capacity respectively). This gave an average occupancy of 15.24 passengers per vehicle. A change in the public transport vehicle fleet was assumed for Do Maximum, resulting in an average occupancy per vehicle of 27.7. This occupancy factor was then applied to BRT vehicles, giving 88.8 passengers per BRT vehicle; similarly, 887 passengers were assumed per train.

11.3.5 Annualization Factors

In order to convert modeled day metrics into annual metrics, a factor of 330 was used. This was estimated as follows.

- 52 × 2 = 110 weekend days per year
- 12 × 1 = 12 holidays per year (i.e. one per month)
- Apply a factor of 1.00 for non-holiday weekdays
- Apply a factor of 0.8 for Saturdays
- Apply a factor of 0.6 for Sundays and holidays
- This gives 329 which is rounded to 330

11.4 Project Cost

Not all costs shown in the financial analysis were included in the economic analysis directly. Vehicle fleet purchase and operating costs for road-running vehicles (i.e. excepting trains) were modeled as part of VOC.

In addition, when undertaking economic analysis a time horizon is set for evaluation, in this case 2035. However, certain infrastructures may have a design life beyond this horizon. As such, a residual value is placed on the remaining value of the infrastructure at the end of the evaluation period. So in 2036 a proportion of certain costs is deducted, relating to such residual valuation. Project Costs in this section relate to costs associated with Do Maximum which are not incurred in Do Minimum.

11.4.1 Cost Streams and Residuals for TPM/Conventional Buses

Cost streams included for TPM/Conventional Buses comprise:

- Construction of 2 large bus stations
- Construction of 4 medium bus stations
- Rehabilitation of current bus stations
- Project costs associated with capacity building

Cost streams, together with the assumed lifetime of each component and residual costs in 2036 are shown in Table 11.7.

11.4.2 Cost Streams and Residuals for Bus Rapid Transit

Cost streams included for BRT comprise three phases of infrastructure. Purchase and operating costs for BRT vehicles are handled as part of VOC. Cost streams, together with the assumed lifetime of each component and residual costs in 2036 are shown in Table 11.8.

11.4.3 Cost Streams and Residuals for Rail

Cost streams included for rail comprise the following.

- Vehicle investment
- Station investment
- Station rehabilitation
- Other infrastructure investment
- Other infrastructure rehabilitation
- Vehicle rehabilitation
- Operating expenses

As described in more detail in later chapters, rail interventions are divided into three phases. Cost streams, together with the assumed lifetime of each component and residual costs in 2036 are shown in Table 11.9.

11.4.4 Cost Streams and Residuals for Road Projects

As described in more detail in Chapter 7, a number of road projects are envisaged. Their construction cost schedules, along with residual costs are shown in Table 11.10 (a 40-year lifetime is assumed in each case). Table 11.11 shows cost schedules for rehabilitation and maintenance.

11.4.5 Cost Streams and Residuals for Traffic Management

As described in more detail in Chapter 9, a number of traffic management projects are envisaged. Their cost schedules, along with assumed lifetime for residuals analysis and residual costs are shown in Table 11.12.

Table 11.7: Project Components, Cost Streams and Residuals for TPM/Conventional Bus (MT Million per Year)

	Life	Year																							
Component	**(Years)**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
2 large stations	40	0.00	0.00	0.00	12.20	12.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-12.51
4 medium stations	40	0.00	0.00	0.00	6.10	12.20	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-12.81
Rehabilitate Current Stations	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88	0.00
Project costs	0	31.57	78.44	62.35	49.09	11.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**n/a**	**31.57**	**78.44**	**62.35**	**67.39**	**35.82**	**6.10**	**0.00**	**0.00**	**0.00**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**4.88**	**-25.32**

Source: JICA Project Team

Table 11.8: Project Components, Cost Streams and Residuals for Bus Rapid Transit (MT Million per Year)

	Life	Year																							
Component	**(Years)**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Infrastructure: Phase I	40	0	0	1,842	1,842	921	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2,280
Infrastructure: Phase II	40	0	0	0	0	0	7,369	7,369	7,369	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-12,711
Infrastructure: Phase III	40	0	0	0	0	0	0	0	0	2,172	2,172	2,172	0	0	0	0	0	0	0	0	0	0	0	0	-4,235
Total	**n/a**	**0**	**0**	**1,842**	**1,842**	**921**	**7,369**	**7,369**	**7,369**	**2,172**	**2,172**	**2,172**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-19,226**

Source: JICA Project Team

Table 11.9: Project Components, Cost Streams and Residuals for Rail (MT Million per Year)

Component	Life (Years)	Year 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Vehicle Investment																									
Phase I	20	0	0	0	0	0	0	3,681	3,681	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1,288
Phase II	20	0	0	0	0	0	0	0	0	0	0	4,090	4,090	0	0	0	0	0	0	0	0	0	0	0	-3,068
Phase III	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,295	4,295	0	0	0	0	0	0	0	-4,939
Station Investment																									
Phase I	40	0	0	0	0	0	0	273	273	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-320
Phase II	40	0	0	0	0	0	0	0	0	0	0	239	239	0	0	0	0	0	0	0	0	0	0	0	-328
Phase III	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136	136	0	0	0	0	0	0	0	-215
Station Rehabilitation																									
Phase I	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	11	11	11	11	11	11	11	11	11	0
Phase II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	10	10	10	0
Phase III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	0
Other Infrastructure Investment																									
Phase I	40	0	0	0	0	0	0	3,729	3,729	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-4,381
Phase II	40	0	0	0	0	0	0	0	0	0	0	4,505	4,505	0	0	0	0	0	0	0	0	0	0	0	-6,194
Phase III	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,522	3,522	0	0	0	0	0	0	0	-5,547
Other Infrastructure Rehabilitation																									
Phase I	0	0	0	0	0	0	0	0	0	0	0	0	0	149	149	149	149	149	149	149	149	149	149	149	0
Phase II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	180	180	180	180	180	180	0
Phase III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	141	141	141	0
Vehicle Rehabilitation																									
Phase I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	736	736	0	0	0	0	0	0	736	0
Phase II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	818	818	0	0	0	0
Phase III	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	859	0
Operating Expenses																									
	0	0	0	0	0	0	0	125	131	134	137	139	142	145	147	150	153	156	159	162	165	168	172	175	0
Total	**n/a**	**0**	**0**	**0**	**0**	**0**	**0**	**7,807**	**7,813**	**134**	**137**	**8,973**	**8,976**	**305**	**307**	**9,000**	**9,002**	**506**	**509**	**1,330**	**1,333**	**665**	**668**	**2,266**	**-26,281**

Source: JICA Project Team

Table 11.10: Project Components, Cost Streams and Residuals for New Road Construction (MT Million per Year)

Component	Year																							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Maputo North-South Arterial (11 projects)	0	0	872	0	0	0	831	0	0	0	305	184	0	0	0	0	0	0	0	0	0	0	0	-1,226
Ring Road & East-West Arterial (9 projects)	0	0	0	0	0	0	0	0	0	241	0	0	0	0	0	0	1,595	1,595	0	0	0	0	0	-2,828
West Matola Industrial Area Arterial (4 projects)	0	0	0	484	0	537	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-537
National Road & Other Arterials (2 projects)	0	324	1,562	1,562	1,562	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2,489
District Arterials & Main Streets (20 projects)	0	0	0	0	253	122	99	553	562	0	0	1,434	0	0	0	0	0	0	0	0	0	0	0	-1,944
Detour Road for Distribution (9 projects)	0	0	0	0	0	0	0	236	242	372	0	0	307	0	0	0	0	0	0	0	0	0	0	-758
District Connection Roads (8 projects)	0	634	245	0	0	225	0	0	0	0	372	0	0	0	0	0	0	0	0	0	0	0	0	-776
Arterials for Land Development (14 projects)	0	0	0	0	0	0	0	0	0	0	0	0	537	1,425	1,425	1,425	0	0	243	708	708	1,174	1,174	-7,468
Total	**0**	**957**	**2,679**	**2,046**	**1,816**	**884**	**930**	**789**	**805**	**613**	**676**	**1,618**	**844**	**1,425**	**1,425**	**1,425**	**1,595**	**1,595**	**243**	**708**	**708**	**1,174**	**1,174**	**-18,027**

Source: JICA Project Team
Note: all projects in this Table have an assumed lifetime of 40 years

Table 11.11: Project Components and Cost Streams for New Road Rehabilitation and Maintenance (MT Million per Year)

Component	Year																							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Rehabilitation of New Roads	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	1.68	2.39	2.41	2.84	2.92	2.95	2.98	3.01	3.04	3.07	3.10	3.13	3.16	0.00
Routine Maintenance of New Roads	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.30	0.43	0.43	0.51	0.52	0.53	0.53	0.54	0.55	0.55	0.56	0.56	0.57	0.00
Periodic Maintenance of New Roads	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03	1.11	1.59	1.60	1.89	1.94	1.96	1.98	2.00	2.02	2.04	2.06	2.08	2.10	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**	**0.09**	**0.09**	**3.10**	**4.40**	**4.45**	**5.24**	**5.38**	**5.43**	**5.49**	**5.54**	**5.60**	**5.65**	**5.71**	**5.77**	**5.83**	**0.00**

Source: JICA Project Team
Note: no residual values applied to elements in this Table; residual values applied in previous table with regards to road construction

Table 11.12: Project Components, Cost Streams and Residuals for Traffic Management (MT Million per Year)

Component	Life (Years)	Year 2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Avenida Angola "reversible" (2 projects)	40	6.41	6.41	6.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-8.65
Bus only section of Av. Guerra Popular	40	4.03	4.03	4.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-5.44
Bolsãos - Benefica and Choupal	40	3.74	3.74	3.74	3.74	3.74	3.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-10.94
Binary systems (5 projects)	40	0.00	0.00	0.00	0.00	0.00	8.85	8.85	8.85	8.85	8.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-26.54
Rail link to Cardenal Alexandre dos Santos	40	0.00	0.00	0.00	0.00	0.00	4.12	4.12	4.12	4.12	4.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-12.37
Geometric improvements (4 projects)	40	0.89	0.89	0.89	0.89	0.89	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.62
ASC Signal System (3 projects)	20	9.40	9.40	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	32.51	0.00	-277.94
Training development of optimization software	0	15.25	15.25	15.25	15.25	15.25	15.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Digital traffic accident database	0	30.50	30.50	30.50	30.50	30.50	30.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Traffic safety programme	0	91.50	91.50	91.50	91.50	91.50	91.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Parking control and land use	0	15.25	15.25	15.25	15.25	15.25	15.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Implementation of HOV lanes	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	-10.37
Number plate control computer system	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74	-28.82
Electronic enforcement	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	-17.08
Total	**n/a**	**176.97**	**176.97**	**200.07**	**189.64**	**189.64**	**202.61**	**45.48**	**45.48**	**45.48**	**45.48**	**32.51**	**32.51**	**39.58**	**39.58**	**39.58**	**39.58**	**39.58**	**39.58**	**39.58**	**39.58**	**39.58**	**39.58**	**7.07**	**-400.76**

Source: JICA Project Team

11.4.6 Assumed Proportion of Project Completion

Whilst the transport model was run for both "Do Minimum" and "Do Maximum" for 2012 and 2035, it would be improper to assume that from 2012 all benefits of Do Maximum could be realized, as projects do not get implemented until later. In order to estimate the approximate proportion of benefits which may be realized in each year, the total cumulative construction cost in each year was calculated and based upon the proportion of construction completed in year *y*, that proportion of benefits could be realized in year *y+1*. These calculations are shown in Table 11.13.

Table 11.13: Assumed Proportion of Project Completion by Year

Year	Construction (MT million)	Cumulative (MT million)	Proportion Completed	Proportion of Benefits Realised
2013	177	177	0.16%	0.00%
2014	1,134	1,311	1.19%	0.16%
2015	4,721	6,032	5.48%	1.19%
2016	4,096	10,129	9.20%	5.48%
2017	2,951	13,079	11.88%	9.20%
2018	8,461	21,541	19.56%	11.88%
2019	16,027	37,567	34.11%	19.56%
2020	15,886	53,453	48.54%	34.11%
2021	3,022	56,475	51.28%	48.54%
2022	2,830	59,305	53.85%	51.28%
2023	11,714	71,020	64.49%	53.85%
2024	10,484	81,504	74.01%	64.49%
2025	884	82,388	74.81%	74.01%
2026	1,464	83,852	76.14%	74.81%
2027	9,418	93,269	84.69%	76.14%
2028	9,418	102,687	93.24%	84.69%
2029	1,635	104,322	94.73%	93.24%
2030	1,635	105,956	96.21%	94.73%
2031	283	106,239	96.47%	96.21%
2032	748	106,987	97.15%	96.47%
2033	748	107,735	97.83%	97.15%
2034	1,214	108,949	98.93%	97.83%
2035	1,181	110,130	100.00%	98.93%

Source: JICA Project Team

11.5 Economic Evaluation Results

11.5.1 Transport Model Outputs

Table 11.14 presents key metrics used in economic analysis, including VOC and VOT as calculated from the transport model outputs. Technical Report O sets out the full range of metrics generated from the transport model runs.

Table 11.14: Transport Model Outputs

	2012			2035		
	Do Minimum	**Do Maximum**	**Max-Min**	**Do Minimum**	**Do Maximum**	**Max-Min**
Passenger Trips by Mode (number per day)						
Car	338,518	337,208	−1,310	1,328,416	1,075,089	−253,327
Truck	74,987	74,747	−240	81,243	81,170	−73
Public Transport	1,312,140	1,313,690	1,550	2,236,750	2,672,502	435,752
Total	**1,725,644**	**1,725,644**	**0**	**3,646,408**	**3,828,760**	**182,352**
Passenger Hours by Mode (hours per day)						
Car	71,270	66,276	−4,994	1,170,861	336,364	−834,498
Truck	35,089	29,534	−5,556	113,369	37,333	−76,036
Public Transport	423,913	630,391	206,478	2,745,617	2,010,770	−734,847
Total	**530,272**	**726,200**	**195,928**	**4,029,847**	**2,384,467**	**−1,645,381**
Vehicle Kilometres by Mode (per day)						
Car	1,549,128	1,459,419	−89,709	9,072,094	7,026,630	−2,045,464
Truck	571,294	521,211	−50,083	693,352	599,424	−93,928
Public Transport	967,875	391,462	−576,412	1,951,453	1,264,464	−686,990
Total	**3,088,296**	**2,372,092**	**−716,204**	**11,716,900**	**8,890,518**	**−2,826,382**
Vehicle Operating Costs (MT/day)						
Car	7,234,648	6,406,539	−828,109	56,884,293	30,346,766	−26,537,527
Truck	12,621,036	10,197,443	−2,423,593	24,927,140	12,071,905	−12,855,234
Bus	11,592,819	1,875,060	−9,717,759	42,852,992	6,232,042	−36,620,950
BRT	0	7,611,823	7,611,823	0	23,860,349	23,860,349
Total	**31,448,503**	**26,090,865**	**−5,357,638**	**124,664,425**	**72,511,062**	**−52,153,363**
CO_2 emissions: grams of carbon per day						
Total	**2,658,544**	**1,785,304**	**−873,240**	**10,810,722**	**5,437,594**	**−5,373,128**
Monetary Value of Passenger Hours (MTn/day)						
Total	**11,469,526**	**16,136,345**	**4,666,819**	**239,048,249**	**143,260,915**	**−95,787,334**

Source: JICA Project Team

11.5.2 Benefit Streams

The figures shown in Table 11.14 are used to interpolate benefits from 2013 to 2035. Applying the factors in Table 11.13 (to account for the proportion of Do Maximum rolled-out by year) then gives estimated benefit streams (monetized VOC, passenger time savings and differences in emissions). These are then annualized using a factor of 330 (as described in sub-section 11.3.5).

Combining these with cost data (from Section 11.4) enables the generation of net benefit streams, as shown in Table 11.15.

Table 11.15: Benefit Streams by Year for Do Maximum versus Do Minimum (MT Million per Annum)

Year	Costs in Year	Benefits in Year	Net Benefits in Year	Cumulative Net Benefits
2013	209	0	−209	−209
2014	1,213	1	−1,212	−1,420
2015	4,783	13	−4,770	−6,190
2016	4,145	84	−4,061	−10,251
2017	2,962	185	−2,777	−13,028
2018	8,461	305	−8,156	−21,184
2019	16,151	630	−15,522	−36,706
2020	16,017	1,356	−14,661	−51,367
2021	3,156	2,356	-800	−52,168
2022	2,971	3,012	41	−52,127
2023	11,861	3,802	−8,059	−60,186
2024	10,635	5,440	−5,195	−65,381
2025	1,198	7,424	6,227	−59,154
2026	1,782	8,888	7,106	−52,048
2027	10,474	10,677	203	−51,845
2028	10,477	13,976	3,499	−48,346
2029	2,151	18,063	15,912	−32,434
2030	2,154	21,494	19,340	−13,094
2031	1,623	25,522	23,898	10,804
2032	2,091	29,867	27,776	38,580
2033	1,423	35,053	33,630	72,210
2034	1,892	41,084	39,192	111,402
2035	3,458	48,301	44,843	156,245
2036	−63,959	0	63,959	220,204

Source: JICA Project Team

11.5.3 Economic Evaluation Results

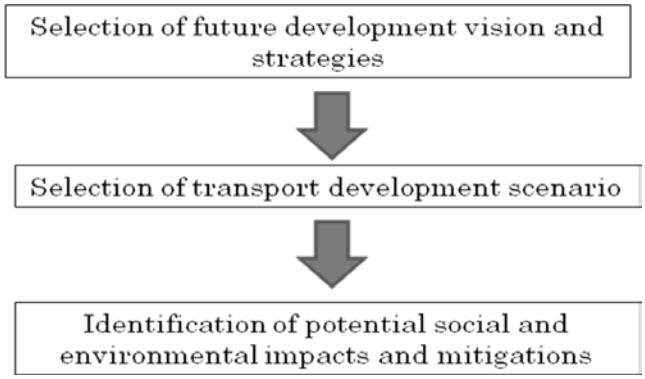
Based upon the data in Table 11.15, the results of economic analysis are calculated to be:

- Economic Internal Rate of Return (EIRR) = 11.5%
- Net Present Value (NPV) at a 6% discount rate = MT 41,952 million
- Net Present Value (NPV) at a 9% discount rate = MT 12,520 million
- Net Present Value (NPV) at a 12% discount rate = −MT 1,855 million
- Project Payback on Day 200 of Year 2030

11.6 Strategic Environmental Assessment on Master Plan

Currently there is no legal requirement for SEA in Mozambique. On the other hand, it is required by JICA's Guidelines for Environmental and Social Considerations (2010) to apply a SEA when conducting Master Plan studies and to ensure environmental and social considerations have been considered from an early stage in the project all the way through to the monitoring stage. Therefore, the SEA was conducted following the JICA Guidelines.

In this study, the SEA approach was applied in three steps as shown in Figure 11.1.



Source: JICA Project Team

Figure 11.1: SEA Process on Maputo Urban Transport Master Plan

First, three potential urban development vision statements were developed as follows and they were compared in terms of their environmental and social implications. The vision with the highest score and therefore was selected as the development vision of the Greater Maputo Area.

Secondly, three alternative scenarios for transport development were developed and compared in order to select the one which can minimize negative impacts on the environment and society. The three scenarios were evaluated on the scale of 1 to 5, where 5 is the best (most preferable) and 1 is the worst (least preferable). The evaluation methods were as follows. All of the components were weighed equally in this assessment. Overall, Scenario C had the highest score. Therefore, it was concluded that Scenario C was the best transport development plan.

Lastly, the potential environmental and social impacts of this master plan were identified as in Table 11.16 and Table 11.17. Potential mitigation measures were also identified.

The most significant impact among all will be caused by involuntary resettlement. Although the exact number of project-affected persons (PAPs) should be assessed in the feasibility studies for each sub project, the total number of the resettlement required for the whole Master Plan is estimated to be more than 2000 households. Depending on the scale of involuntary resettlement caused by each sub-project, the preparation of Resettlement Action Plan (RAP) may be required according to the regulations of Mozambique and JICA Environmental and Social Guidelines. The RAP should include appropriate compensation program, support system for resettlement and livelihood restoration, grievance redress mechanism, information disclosure, and monitoring plan.

In accordance with JICA's Guidelines for Environmental and Social Considerations (2010), a public consultation meeting was held on 19 June 2013. Approximately 230 people attended this meeting. There were a wide range of attendees, including municipal councilors, representatives from relevant organizations such as INATTER and Maputo Sul, from foreign embassies, from the private sector, persons from the media, and students.

Table 11.16: Potential Social/Environmental Impacts and Mitigation Measures for the Greater Maputo Urban Transport Master Plan (during Construction)

No.	Check Items	Rating	Notes	Mitigation
Social Environment				
1	Involuntary resettlement	A	The master plan is expected to cause involuntary resettlement of more than 2000 households.	Resettlement Action Plan (RAP) needs to be made including compensation and resettlement assistance program.
2	Economic Activities	D	The master plan will positively affect local economy by providing employment opportunities	
3	Traffic and public facilities	B	The master plan may have some negative effects on traffic due to temporary closures of roads for construction of BRT, railway, etc.	The construction works should be planned to minimize impacts on local traffic. The possible mitigation measures are, for example, providing bypass road or avoiding construction works during peak hours.
4	Split of communities	D	The master plan will not cause split of local communities.	
5	Cultural property	D	The master plan will not have any impacts on cultural sites.	
6	Water rights and right of common	C	Traditionally, Mozambican communities have socially protected commons (such as graveyards, water reservoirs) which are not recognized officially.	The projects should be planned to avoid these socially protected areas.
7	Health, sanitation and hazards.	B	The construction workers may be exposed to dangers of injuries, bad sanitation, and health problems. Appropriate mitigation measures are necessary.	Mitigation measures will include making safety and health guidelines and educating workers, as well as following labor-related laws and regulations in Mozambique.
Natural environment				
8	Topography and geological features	D	The master plan will not have any impacts on topography.	
9	Soil erosion	A	There may be incidents of soil erosion during construction especially in rainy season.	Appropriate mitigation measures need to be taken to prevent soil erosion and/or other environmental impacts.
10	Groundwater	D	The master plan will not affect groundwater flows.	
11	Hydrological situation	D	The master plan will not affect the aquatic environment.	
12	Flora, Fauna and Biodiversity	D	The master plan will not affect biodiversity because it concerns urban area and there is no rare, endangered or protected species.	
13	Meteorology	D	The master plan will not affect meteorology.	
14	Landscape	B	During construction, some street trees may need to be cut down.	The traffic infrastructures should be designed not to spoil the landscape, and incorporate green zones as much as possible.
15	Global warming	B	The construction activities may increase the emission of CO_2.	CO_2 emission should be minimized by using low-emission machines and maintaining them in good condition.

No.	Check Items	Rating	Notes	Mitigation
Pollution				
16	Air pollution	B	The construction activities may increase the emission of some air pollutants.	Emission should be minimized by using low-emission machines and keeping good maintenance. The amount of emission should comply with Mozambican legal standards for air quality.
17	Water pollution	D	The master plan is not likely to cause water pollution.	
18	Soil contaminations	D	The master plan is not likely to cause any soil contamination.	
19	Waste	B	Industrial wastes may be produced during construction.	The wastes should be treated and disposed appropriately in compliance with Mozambican environmental regulations.
20	Noise and vibration	B	There will be significant noise and vibration in and around the construction area.	The level of noise and vibration caused by construction works should be kept under Mozambican legal limit.
21	Ground sinking	D	The master plan is not likely to cause any ground sinking.	

Rating:
A: Serious impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown.
D: No or negligible impact including positive impact is expected.

Source: JICA Project Team

Table 11.17: Potential Social / Environmental Impacts and Mitigation Measures for the Greater Maputo Urban Transport Master Plan (during Operation)

No.	Check Items	Rating	Notes	Mitigation
Social Environment				
1	Involuntary resettlement	D	No involuntary resettlement will be caused during operation.	
2	Economic Activities	B	While the employment in public transport sector may be increased, there may be negative effects on some businesses (such as chapa operators)	Assistance for livelihood restoration of negatively affected people must be provided.
3	Traffic and public facilities	D	The master plan will have positive effects on traffic and public transport.	
4	Split of communities	D	The master plan will not cause split of local communities.	
5	Cultural property	D	The master plan will not have any impacts on cultural sites.	
6	Water rights and right of common	D	There will be no impact on water rights.	
7	Health and sanitation	D	There will be no impact on health and sanitation.	
8	Hazards	C	There may be chance of traffic accidents, although the number of accidents is expected to reduce with more people using public transport such as BRT/Railway.	The chances of traffic accidents should be minimized by designing safety-oriented infrastructures and careful operation.
Natural environment				
9	Topography and geological features	D	The master plan will not have any impacts on topography.	

No.	Check Items	Rating	Notes	Mitigation
10	Soil erosion	D	The master plan will not cause soil erosion.	
11	Groundwater	D	The master plan will not affect groundwater flows.	
12	Hydrological situation	D	The master plan will not affect the aquatic environment.	
13	Flora, Fauna and Biodiversity	D	The master plan will not affect biodiversity.	
14	Meteorology	D	The master plan will not affect meteorology.	
15	Landscape	D	The master plan will not affect landscape.	
16	Global warming	B	The master plan will cause some CO_2 emission.	The source of energy for public transport system should use renewable energy as much as possible
Pollution				
17	Air pollution	D	The master plan will reduce the air pollution by providing public transport and reducing number of cars.	
18	Water pollution	D	The master plan is not likely to cause water pollution.	
19	Soil contaminations	D	The master plan is not likely to cause any soil contamination.	
20	Waste	D	The master plan is not likely to cause industrial wastes.	
21	Noise and vibration	B	There may be increased noise and vibration caused by train/BRT.	The level of noise and vibration in the surrounding commercial and residential area should be kept under the legal limits of Mozambique.
22	Ground sinking	D	The master plan is not likely to cause any ground sinking.	

Rating:
A: Serious impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown.
D: No or negligible impact including positive impact is expected.

Source: JICA Project Team

Chapter 12 Institutional Improvement and Capacity Development Programs

12.1 Institutions and Capacity Development Issues

Successful implementation of the proposed projects and occasional updating of the master plan requires the presence of appropriate institutional arrangements and capacity/capability of the organizations and individuals involved. One of the major issues for development and implementation of urban transport projects in Greater Maputo has been the lack of effective coordination mechanisms between and among central, provincial, and municipal governments. At the local government level, urban development plans have been prepared within respective administrative boundaries, and there have been few common policies or strategies for the metropolitan area development that are shared among all of the relevant organizations. Various government agencies including central agencies have prepared and implemented urban transport projects without sufficient coordination with the local governments concerned. Many of these plans and projects, when implemented, will have major impacts on future urban development patterns in Greater Maputo. Accordingly, there is an urgent need to improve urban transport institutions and policy coordination mechanisms in the Maputo metropolitan area.

The regulation of transport services is another example where a coordinated approach is required at the metropolitan level. Currently, private bus licenses are issued by municipalities and provinces. The licensed routes may extend across the administrative boundary of the city where the licenses are issued. For example, private buses registered in Maputo City can operate across the boundary in Matola, and buses registered in Matola can operate in Maputo area. Provincial governments also independently issue licenses for long-distance bus routes that partially overlap with the municipality-licensed bus routes. Due to weak enforcement there are a substantial number of unregistered private buses as well. A clearer demarcation of regulations is required together with improved policy coordination mechanisms. This type of issue may need to be addressed through a metropolitan-level urban transport institution.

In addition, there is a requirement for development of the capacity of local administrative organizations in the study area. Under *ProMaputo* I and II the Maputo Municipal Government undertook organizational reform and capacity development programs. Part of its achievement was improvement of land use planning capacity. Infrastructure planning and implementation capacity have been relatively strong and a 2001 JICA project for Maputo assisted in preparing a road network development plan. In recent years, transport and traffic capacity has also been improved through creation of a department responsible for this sector by separating a unit from the department generally in charge of infrastructure. The Directorate of Municipal Transport and Traffic (DMTT) can perform many of the currently designed tasks with relatively well-qualified staff. However, the division has insufficient skills required for the preparation and implementation of an urban transport master plan. Also, the public transport division may have to be substantially strengthened in terms of number of staff and skills to perform its designed tasks.

The remaining local administrative bodies have even weaker organizational capacities compared to the organizations with similar functions in Maputo City. There is a shortage of qualified staff in Matola City as well as Boane City and Marracuene District. Since there is an urgent need to improve metropolitan-wide policy coordination, the divisions with similar functions in the municipalities and districts should cooperate with each other to develop policies, strategies, plans, and projects that extend across the metropolitan area.

In relation to the shortage of qualified staff in public/private organizations, strengthening of higher education institutions in the provision of transport- and traffic-related courses may also

be required. Subjects on road network development have been included in most of civil engineering courses in Mozambique but the number of students is considered to be small compared to the country's needs. While qualified staff is in short supply in government agencies, higher education institutions providing transport and traffic courses are extremely limited in Mozambique. At the University of Eduardo Mondlane (Universidade Eduardo Mondlane, UEM), sufficient hours are spent in road engineering courses but there is no program specialization in transport planning or traffic engineering. A private institution in Maputo, the Higher Institute of Transport and Communication (Superior de Transportes e Comunicações, ISUTC), offers courses in transport and communications but it has no courses in transport planning or traffic engineering. Although higher degrees can be obtained overseas in these specialized subjects, there are needs and opportunities to improve the capacity of domestic educational institutions to include more subjects relating to transport and traffic studies.

In this chapter, the following three institutional improvements and capacity development measures are proposed:

- Establishment of a Greater Maputo Metropolitan Transport Agency
- Assessment of Master Plan implementing organizations
- Establishment of an Institute for Transport and Traffic Studies

12.2 Greater Maputo Metropolitan Transport Agency (GMMTA)

12.2.1 Background and Issues, and Improvement Options

One of the major issues regarding urban transport development in Greater Maputo is a lack of effective coordination mechanisms among central, provincial, and municipal governments. At the local government level, the urban development plans have been prepared within respective administrative boundaries. As a result, there are few common policies or strategies for the metropolitan area development that are shared among all of the relevant organizations. Meanwhile various government agencies including central agencies are preparing and implementing urban transport projects without sufficient coordination with concerned local governments. Many of those plans and projects, when implemented, would have major impacts on the future form of urban development patterns in Greater Maputo. There is an urgent need to improve urban transport institution and policy coordination mechanisms in the Maputo metropolitan area.

In the past, coordination of transport network development has been made though the 'Mobility Committee.' The Mobility Committee was established in 2008, and was made up of 13 members from seven organizations.[1] The committee used to hold regular meetings but it was functioning as a forum and their decisions did not have any legal obligation for the participating member organizations.

Recently, in parallel with the preparation of this JICA project, Maputo City has also taken initiatives to create a new Mobility Committee which addresses metropolitan-wide issues through representatives of the relevant municipalities and districts. The participation of national government agencies however, is considered to be essential to successfully coordinating policies and strategies in Greater Maputo. In its Official Letter No. 37/GP/2012 dated February 10, 2012, the President of the City Council urged that Metropolitan Commission of Transport should be established for an efficient, viable, and sustainable coordination mechanism. The letter stated that Maputo Metropolitan Area exceeds the boundary of Maputo Municipality, and

[1] The Mobility Committee was chaired by the CEO of INATTER (INAV in that time).

the creation of the new organization is necessary to support the preparation and implementation of the urban transport master plan.

Similar issues in urban transport institutions are shared in many other cities worldwide (Technical Report I shows the case study results). There are examples with 'problems' and examples with 'good practices'. Based on these case studies, an establishment of a metropolitan wide agency responsible for whole Maputo Metropolitan Area is recommended for further consideration.

12.2.2 Objectives and Functions of the GMMTA

The proposed Greater Maputo Metropolitan Transport Agency (GMMTA) will mainly be a recommendatory and coordination body with some exceptions. All modes and aspects of transport including railway, waterborne transport, roads and road transport, bridges, and traffic management, in the Greater Maputo Metropolitan Area will be addressed by the agency. The aim is to ensure effective implementation and coordination of the various transport and traffic measures undertaken by relevant agencies in the Greater Maputo Metropolitan Area.

The GMMTA can be established as a public company, and have several sector units (or departments) such as roads, public transport, and traffic management. A research/training unit is also envisaged. Supervising organizations would include Maputo Municipality, Matola Municipality, Boane City, Marracuene District, and the Ministry of Transport and Communications.

The major responsibilities of the GMMTA will be to:

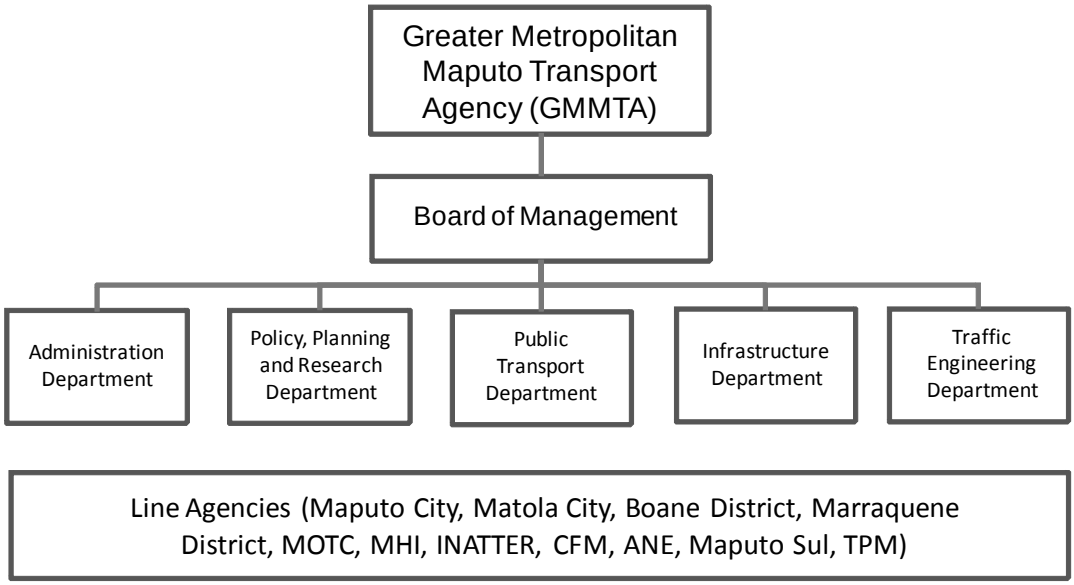
- prepare a transport master plan for the Greater Maputo Metropolitan Area (ongoing with the assistance of JICA)
- update the transport master plan periodically in tune with changes in the traffic and transport environment in the region
- coordinate and monitor the implementation of the transport master plan
- coordinate and recommend effective transport and traffic management strategies for the Greater Maputo Metropolitan Areas
- ensure that effective public transport systems are in place for the Greater Maputo Metropolitan Area
- ensure effective coordination, implementation, and monitoring of various transport and traffic proposals/projects undertaken by various departments
- integrate and regulate the operation of buses and chapas operated within the metropolitan area
- integrate various routes of public transport and issues of combined ticketing, feeder services, and the like
- recommend the use of funds from various departments and agencies to ensure implementation of the transport and traffic plans and measures

An escrow account may be maintained in the unit in which certain percentage of the estimated cost of all traffic and transport projects undertaken by various agencies and other local urban bodies would be deposited. These amounts may be utilized for research, studies, and training in the field of traffic and transport apart from the administrative expenses of the agency

Key organizations involved in the GMMTA include:

- Maputo City
- Matola City
- Maputo Province
- Boane City
- Marracuene District
- Ministry of Transport and Communications (MOTC)
- Ministry of Finance (MOF)
- Ministry of Public Works and Housing (MPWH)
- National Land Transport Institute (Instituto Nacional dos Transportes Terrestres, INATTER)
- Mozambique Ports and Railways (Portos e Caminhos de Ferro de Moçambique, CFM)
- Maputo Sul

A tentative organizational structure of the agency is shown in Figure 12.1.

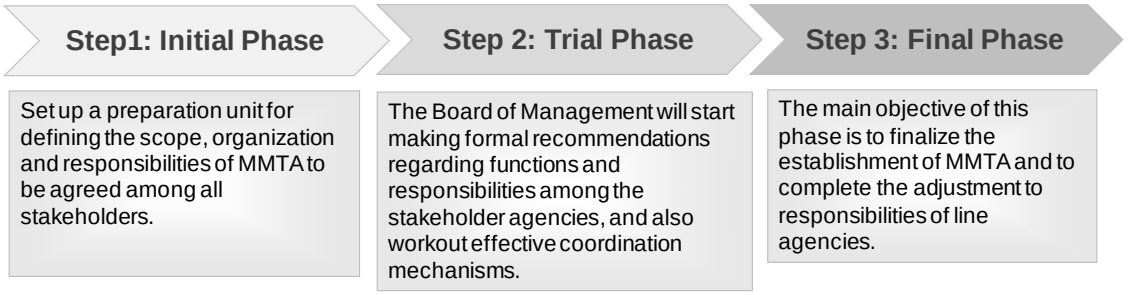


Abbreviations: ANE = National Roads Administration (Administração Nacional de Estradas), CFM = Mozambique Ports and Railways (Portos e Caminhos de Ferro de Moçambique), MHI = Ministry of Housing and Infrastructure, MOTC = Ministry of Transport and Communications, TPM = Transportes Publicos de Maputo (the public bus company in Maputo)
Source: JICA Project Team

Figure 12.1: Tentative Organizational Structure of GMMTA and Its Relationship with Line Agencies

12.2.3 Suggested Process for Establishing the GMMTA

The proposed GMMTA can be established in three steps as shown in Figure 12.2. The above-mentioned objectives, functions, responsibilities of the agency will be revised or elaborated in three phases.



Source: JICA Project Team

Figure 12.2: Proposed Process for Establishing the GMMTA

(1) Step 1: Initial Phase

During Step 1, a preparation unit will be established for defining the detailed scope, organization, and responsibilities of the GMMTA to be agreed among all stakeholders. Key activities during this phase will include:

1. Identification of key areas of the urban transport subsector in the Greater Maputo Area (e.g., road network, public transport, traffic management) that require effective coordination
2. Documentation of the relevant laws and regulations relating to all key agencies to be involved in the GMMTA
3. Analysis of the organizational structure, functions, and responsibilities of stakeholder agencies in relation to the improvement of urban transport systems in Greater Maputo Area
4. Recommendations on adjustment of the functions and responsibilities of the stakeholder agencies
5. Clarification of necessary details and actions to be taken by the GMMTA to start performing its initially agreed mandate
6. Identification of necessary regulations to establish the GMMTA
7. Submission of recommendations to the Board of Management on any decisions and/or actions regarding the above matters

A limited number of personnel are required at this stage as shown in Table 12.1.

Table 12.1: Personnel Requirements for the Initial Phase for Establishing the GMMTA

Subunit	Number of Persons	Suggested Personnel
Board of Management	10–12	Representatives from key municipal/national agencies relating to urban transport in Greater Maputo
Secretariat	2–3	Staff responsible for organizing board meetings and keeping records
Technical Division	Several	Experts from core implementation agencies and a few external experts specialized in urban transport

Source: JICA Project Team

The Technical Division will function as Project Implementation Unit (PMUs) for the Master Plan implementation, and maintain contact with all stakeholders to assist the board of management to collect and analyze relevant information.

(2) Step 2: Trial Phase

Based on the recommendations taken during the Initial Phase, the Board of Management will start making formal recommendations regarding the functions and responsibilities of the stakeholder agencies, and also work out effective coordination mechanisms. Specific tasks in this phase include:

1. Development of the detailed organizational structure, functions, and responsibilities of the final form of the GMMTA
2. Establishment of the Planning and Research Division within the GMMTA to accumulate a knowledge database relating to transport/traffic issues and planning in Greater Maputo
3. Formulation of necessary adjustments required in the structure, functions, and responsibilities of existing stakeholder organizations
4. Preparation by each stakeholder organization of plans for implementing the required adjustments
5. Streamlining and integration of the functions and responsibilities of the GMMTA and line agencies within each of the urban transport subsectors identified in the Initial Phase
6. Identification of requirements for establishing new agencies in the urban transport subsector in fields where there is currently no implementing agency working across administrative boundaries (e.g., BRT, commuter rail management/regulation in Greater Maputo)

Table 12.2 estimates personnel requirements for the Trial Phase.

Table 12.2: Tentative Personnel Requirement for Trial Phase

Subunit	Number of Persons	Suggested Personnel
Board of Management	10–12	Representatives from key municipal/national agencies relating to urban transport in Greater Maputo.
Secretariat	2–3	Staff responsible for organizing board meetings and keeping records.
Technical Division	Several	Experts from core implementation agencies and a few external experts specialized in urban transport.
Planning and Research Division	3	Experts with relevant post graduate degrees such as urban transport planning, town planning, and finance and economics.

Source: JICA Project Team

(3) Step 3: Final Phase

The main objective of this phase is to finalize the establishment of the GMMTA and to complete the adjustment of the responsibilities of the line agencies. More specific tasks in this phase include:

1. Finalization of the adjustment of responsibilities of line agencies
2. Creation of internal departments within the GMMTA to effectively perform its functions and responsibilities
3. Allocation of the required resources to make the GMMTA fully operational

Table 12.3 shows the tentative personnel requirement for the Final Phase.

Table 12.3: Tentative Personnel Requirement for the Final Phase

Subunit	Number of Persons	Suggested Personnel
Board of Management	10–12	Representatives from key municipal/national agencies relating to urban transport in Greater Maputo.
Administration Department	4–5	Staff responsible for financial management, personnel management, and other administrative tasks. In addition, administrative staff organize board meetings and keeping meeting records.
Policy, Planning and Research Department	7–8	Staff with academic qualifications in the field of traffic and transport is required, who support overall technical requirement of GMMTA and training needs of other technical departments.
Public Transport Department	8–9	Representatives from Public Transport division of DMTT Maputo, DMTT Matola, and Boane and Marracuene
Infrastructure Department	5–6	Representatives from DMI Maputo, DMI Matola, Boane City, Marracuene District, ANE, Maputo Sul.
Traffic Engineering Department	10–15	Staff of Traffic Engineering Division of DMTT Maputo will be transferred to this department to engage in the metropolitan wide traffic management requirement.

Source: JICA Project Team

Responsibilities of key internal departments are described below:

The *Administration Department* will serve as the secretariat of the Board of Management, handle legal and financial issues, and deal with human resources.

The *Policy, Planning, and Research Department* will be responsible for a coordinated development of transport infrastructure and services based on the urban transport master plan. It will also be responsible for creating and managing a knowledge database including study reports and traffic data, which will be used to formulate urban transport policies, update the master plan, and provide research assistance to other technical divisions. The database will help in monitoring and understanding the various traffic and transport requirements of the region. The department will function as a center for technology transfer and also guide the local authorities for all their technical requirements in the field of traffic and transport. Technical support staff and secretariat assistance to the GMMTA will be provided by this department.

The *Public Transport Department* will be responsible for all modes of public transport systems including commuter rail services, BRT, taxis, buses, and chapas. The department will regulate all public/private operators operating within the Greater Maputo Area, and will be responsible for providing basic user information such as route maps, fares, and the latest operating schedules of all regulated services. Furthermore, the department will absorb some existing departments and agencies within the local government.

The *Infrastructure Department* will be responsible for coordinating the construction and maintenance of rail, BRT facilities, roads, bridges, tunnels, pedestrian facilities, bus terminals/ stops, and intermodal facilities. It will prepare common design standards and monitor the construction and maintenance of key infrastructure by line agencies.

The *Traffic Engineering Department* will deal with signals, intersection, signs and markings, one-way systems, traffic control systems, and various other traffic management measures (e.g., the design of bus priority lanes, high-occupancy vehicle (HOV) lanes, pedestrian malls).

Under the initiatives of the GMMTA departments, the subgroups of line agencies will be organized to discuss specific topics such as the following.

- Comprehensive Traffic and Transportation Plan
- BRT systems
- the commuter rail system
- Bus and chapa routes and operations
- intermodal terminals
- integrated fare and common ticketing
- parking policy and infrastructure
- external development and infrastructure charges
- codes and guidelines for roads and intelligent transport system (ITS) facilities

12.2.4 Capacity Building Project for the Establishment of the GMMTA

Due to the shortage of qualified staff and experience within the existing organizations, support will be required to establish the Greater Metropolitan Maputo Transport Agency. The proposed Capacity Building Project for the Establishment of the Greater Metropolitan Maputo Transport Agency is described below:

Project Objectives: Assist the initial phase of the GMMTA and assist the organization to carry out its responsibility to coordinate policies, plans, and projects of the transport-related government agencies in the Greater Maputo Metropolitan Area.

Implementing Agency: Maputo City, Matola City, Boane City, and Marracuene District

Project Period: Initial Phase (three years)

Outputs:
1. Establishment of coordinating body (secretariat and committee)
2. Analysis of requirement for capacity building and provision of appropriate training for transport planning
3. Discussion of various project proposals by stakeholder agencies
4. Coordination of realistic transport-related project proposals
5. Monitoring of and reporting on progress of committed and ongoing projects
6. Clarification of training equipment requirements
7. Formulation of detailed training programs
8. Implementation of training
9. Updating of functional responsibilities and assigned tasks and assessment of capacity gaps
10. Identification of inter-organizational coordination issues and formulation of improvement measures
11. Monitor progress of master plan projects and other relevant projects

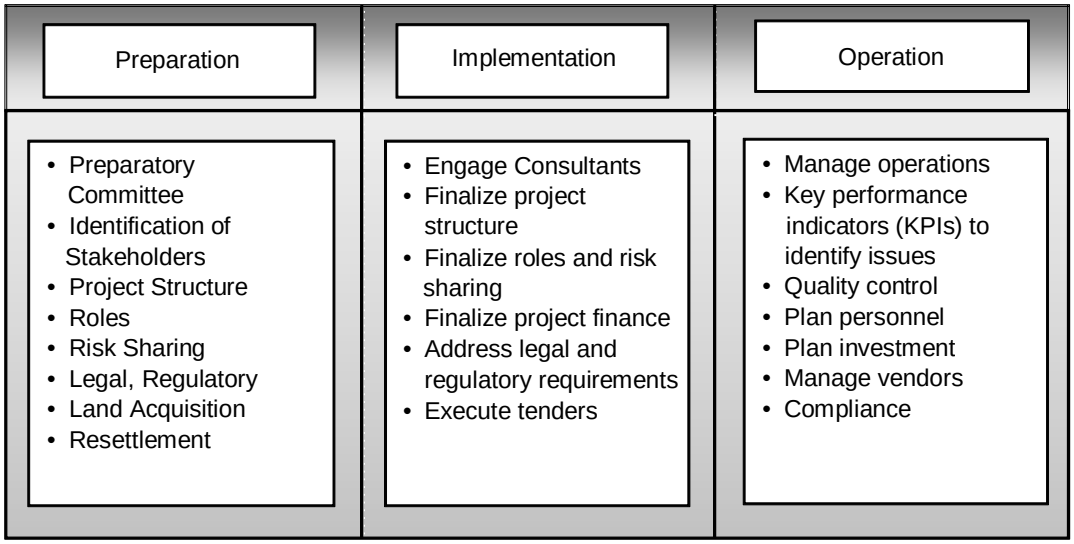
Consultant Inputs:
1. Team Leader/Transport Policy
2. Transport Planning
3. Institutions and Capacity Building
4. Traffic Surveys and Analysis
5. Coordination
6. Equipment

Counterpart Agency Inputs:
1. Project Director
2. Administrative and technical staff representing key counterpart agencies

12.3 Assessment of Master Plan Implementing Organizations

12.3.1 Master Plan Implementation Process

Implementation of the Master Plan projects will require cooperation among various stakeholders and extensive planning. A basic diagram of the implementation process is shown in Figure 12.3.



Source: JICA Project Team

Figure 12.3: Master Plan – Implementation Process

(1) Preparation

The preparatory committee will consider a project or a group of projects and begin to investigate the following aspects of implementation:

Identification of stakeholders – Stakeholders include any person or organization that is important for the execution of the project (controlling needed resources and/or authority) or will be materially impacted by the project. Identifying stakeholders early and understanding their requirements for supporting the project will facilitate implementation and ease the process of resolving issues as they arise.

Preliminary design of project structure – In general, a project structure will include an Executing Agency (EA), an Implementing Agency (IA), and in the case of PPP transactions, private sector investors:

a. Executing Agency – The government agency charged with planning and executing the project, providing overall leadership, policy guidance, and institutional and stakeholder coordination as required for project preparation and implementation.

b. Implementing Agency – The IA is responsible for putting the project in place, including scheduling, tendering for construction and procurement, managing construction, developing the financial and operating models, hiring staff, contracting with vendors, and developing policies and procedures to operate the business created by the project. The IA can either be a unit within an existing government agency or a newly established

entity. A new entity often has the benefit of a clearly defined mission without the distractions of existing responsibilities. A separate entity may also facilitate other objectives such as structuring the new operation to be managed and operated along private sector lines.

c. Private investors – Private sector organizations can be involved as investors/operators in a PPP structure or as contract service providers (e.g., an operating and maintenance contract for the BRT).

Choosing an Executing Agency is the first step in establishing a project structure. Where multiple projects are planned as in the Comprehensive Urban Transport Master Plan for Greater Maputo (the Master Plan), early consideration is given to whether it is better to have multiple EAs or a single EA over the entire Master Plan. As discussed below, it is recommended that a single EA be appointed for the Master Plan. Once on board, the EA will proceed to understanding the concerns of the stakeholders and identifying the steps to complete the project.

Roles – A clear definition of roles, and therefore expectations, for each organization involved is critical for efficient execution. A clear demarcation of authority and responsibility is necessary between the EA and the IA. Stakeholders should know what is expected of them. For example, the Ministry of Finance at the central government level should understand the amount and form of financial support that is assumed from the central government. Establishing roles involves negotiation with various parties on issues such as financial resources, government approval procedures, legal requirements, and regulatory considerations.

Risk Sharing – This refers mainly to financial risk but also includes legal risk and operational risk. Financial risks affect the entities responsible for project financing and the entities responsible for financial support during the Master Plan operating phase. These risks are shared in some proportion among the various levels of government (central and local), the IA (as the project operator), and in the case of a PPP, private investors. Legal risks include obligations created by contracts associated with the project and complaints of improper use of government authority or resources. Legal risks are shared in similar fashion as financial risks.

Legal and regulatory requirements – There can be a requirement to revise or amend existing laws or regulations to allow a project to proceed as planned. For example, there may be a law restricting ownership of certain infrastructure assets to only the central government. If the project approach envisions a local government entity owning project assets, it would be necessary to address the legal aspects. This can be a long process and research should begin early on.

Land acquisition and resettlement – Infrastructure projects, especially transportation projects, often necessitate acquiring privately owned land and resettling residents. It may also be necessary to resettle people living on public land. Models exist for acquiring land and resettling individuals in a fair and equitable way that the Executing Agency can refer to when developing the Land Acquisition and Resettlement Action Plan (LARAP).

(2) Implementation

Project implementation is a significant effort and can take several years for large infrastructure projects. Outlined here are the major tasks in bringing a project to fruition.

Engage Consultants – As the tasks become more technical and require more time, it is helpful to engage consultants both for expertise and for resources. Generally, consultants are used in the following areas:

a. Basic design, detailed design, and tender assistance – Engineering consultants prepare the technical specifications and drawings to be used to tender the project. Tender processes usually consist of a preliminary round to identify suitable firms (Expression of Interest) followed by the process to select firms to build the project (Consultant Selection). Consultants also assist in evaluating potential bidder qualifications, assessing individual bid proposals, and negotiating contracts.
b. Construction management – The Construction Management Consultant (CMC) is the IA's project manager. The CMC interacts directly with contractors performing the construction work, approves completed work, and approves requests for payment.
c. Legal and regulatory consultants – Legal and regulatory consultants advise on changes to existing laws or regulations that are necessary to implement the project, including establishing proposed new incorporated entities. These consultants also provide advice on contracting with construction companies and other contract service providers to be used during operations.
d. Capacity building – Consultants with expertise in identifying skill requirements and training assist the new and existing organizations in preparing to handle the new management requirements.
e. Organization design –Specific organizations are developed including identification of management positions, staff requirements, position descriptions, compensation schemes, performance appraisal procedures, and standard operating procedures (SOPs).
f. Quality control/continuous improvement – Quality control systems are implemented to support problem identification and resolution and to continually evaluate and improve procedures and outcomes.
g. Business planning – Business planning consultants assist in identifying market demands and designing services that will best serve the target markets and maximize income.
h. Operations planning – Techniques for designing and executing day-to-day operations are developed. The focus is on efficiency and quality service.
i. Financial planning – Financial planning consultants evaluate the financial and economic returns from proposed projects and draft accounting and financial management policies and procedures.
j. Development finance institutions such as JICA and the African Development Bank often require the use of consultants in these areas to support successful execution.

Finalize project structure – The final structure is chosen with the EA and the IA identified. A key element to address is the nature of the IA. Is it a newly incorporated entity with a separate management and board or a group within an existing agency? A factor to be considered in this decision is what happens when the Master Plan project is completed. Certain projects may easily be absorbed by an existing agency. Some of the proposed road projects are in this category. Others, such as the BRT and Suburban Rail projects, could benefit from a newly established entity that would continue as the operator after project completion.

Finalize roles and risk sharing – Final determinations regarding the role of the EA, IA, and other entities are made. This addresses the implementation and operating phases. While the broad demarcation between the EA as the executive manager and the IA as the operations manager may be readily accepted, there are elements that may not be as simple. For example, what is the role of the EA in developing additional income for the transit operation? Is it more effective to be actively involved or remain in the role of reviewing and approving proposals made by the IA?

Finalize project finance – Final decisions are made regarding sources of financing and obligations for repayment of loan financing. Earlier in this chapter, several financing sources were discussed. Allocation of the obligation to repay project loans is a question for Conventional Bus, BRT, and Suburban Rail income producing projects. The financial profile estimated for a given project will determine the appropriate distribution of responsibility. In simple terms, if the project entity is expected to collect revenue sufficient to cover operating costs, then the entity has capacity to accept a certain level of repayment obligation.

Address legal and regulatory requirements – The desired legal and regulatory structure for the project is determined and the processes for enacting new and revising existing laws and regulations are pursued.

Conduct the tender process and procure the project – The tender process is completed, contractors are selected, and contracts are signed. Tendering may occur in several stages. For instance, large projects may have an initial tender to complete a feasibility study followed by tenders to implement the project.

(3) Operation

In the operation phase, the agencies are focused on service delivery:

- Manage operations – The objective is high customer satisfaction and efficient service delivery.
- Key Performance Indicators (KPIs) – KPIs measure activity to understand how outcomes occur, identify areas of concern, and create action plans to address those areas.
- Quality control – Quality control involves continuous review and action to improve procedures, customer satisfaction, and performance. KPIs are inputs to quality control/quality assurance activities.
- Personnel planning – Personnel requirements are anticipated to the degree possible. Recruiting avenues are developed. Compensation schemes are created and constantly reviewed.
- Investment planning – Annual and long-range (3–5 year) investment plans are maintained to identify and prepare financial and other resources.
- Vendor management – Performance, cost, adherence to contracts, and ease of the relationship are primary considerations.
- Compliance – Procedures are put in place to meet compliance requirements including tax reporting, permitting, and compliance with personnel laws and regulations.

12.3.2 Overall Implementation Organization

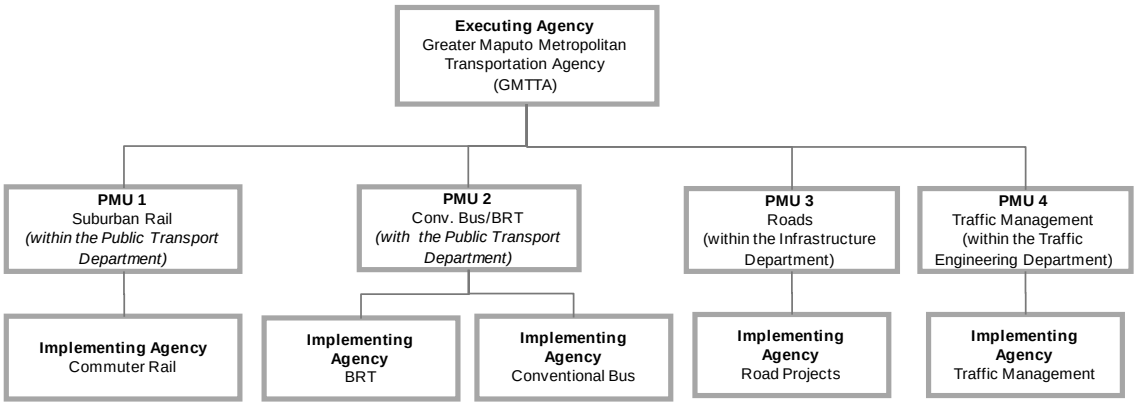
The following institutional arrangements are recommended for implementing the Master Plan projects.

The proposed GMMTA should serve as the EA for all Master Plan projects. This should ensure consistent overall leadership, policy formulation, and coordination of institutional roles. A single EA will be most effective in considering the broad scope of projects and managing scheduling, financing, and other tradeoffs that inevitably will occur.

IAs should be established for each Master Plan project although it may be possible to have a single IA manage multiple road projects. The main concern is assuring that the IA has sufficient capacity to effectively manage the assigned projects.

Project Management Units (PMUs) monitor project activity and seek to ensure completion of the projects according to schedule and budget. The PMUs work with the IAs and have decision-making authority in most areas except for those that are reserved for the EA.

Figure 12.4 displays a tentative implementation structure and the relationship between the respective entities:



Source: JICA Project Team

Figure 12.4: Master Plan – Project Implementation Organization

In addition to acting as the EA for the Master Plan projects, the GMMTA will be in charge of planning, regulation, and management of the metropolitan Maputo transport sector. Its main responsibilities will include transport development planning, as well as regulating and monitoring of urban transport, highways, and waterway public transport. It will also be responsible for transport sector policymaking, institutional reform, fare and tariff regulation, and fair competition. The GMMTA organization is to include a Board of Commissioners, Managing Director, Directors for each of the transport modes, a Director of Policy and Planning, a Director of Finance, a Director of Operations and Maintenance, and a Director of Safety. In addition, there will be various technical experts, project managers, and analysts within each director's organization.

Project Management Units (PMUs) work closely with the IAs to ensure efficient execution of projects. This includes regular monitoring of progress, resolving issues that the IAs are unable to resolve, and requesting information from the IAs as necessary to monitor budgets, contractor performance, and progress versus established schedules. It is recommended that at a minimum three PMUs be created for Conventional Bus and BRT, Road and Traffic Management, and Suburban Rail.

12.3.3 Suggested Implementing Agencies

It is recommended that separate IAs be established for a manageable group of projects in each of the five Master Plan categories. The IAs will be responsible for the day-to-day management and coordination of project preparation and implementation activities. Table 12.4 outlines the suggested IAs for each Master Plan project.

Table 12.4: Suggested Implementing Agencies

Project Component	Suggested Implementing Agency/Agencies
Road Network	• **Infrastructure Department of GMMTA (when established**
➢ Maputo North/South Arterial	• DMI Maputo, DDI Marracuene
➢ Ring Road and East/West Arterial	• ANE, Maputo Sul, DMI Maputo, DDI Marracuene
➢ W. Matola Industrial Area Arterial	• ANE, DMI Matola
➢ National Roads, Other Arterials	• ANE
➢ District Arterials, Main Streets	• ANE, DMI Maputo, DMI Matola
➢ Distributor Roads	• DMI Maputo, DMI Matola
➢ District Connector Roads	• DMI Maputo, DMI Matola
➢ Arterials for Land Development	• DMI Maputo, DMI Matola, DDI Marracuene, DDI Boane
Suburban Rail	• **Public Transport Department of GMMTA (when established)**
• Double Track: Maputo–MatolaGare	• New autonomous entity under the GMMTA
• Double Track: Maputo–Marracuene	• New autonomous entity under the GMMTA
• Double Track: Machava–Boane	• New autonomous entity under the GMMTA
	Note: it may be possible to have all three Double Track projects under one IA.
Bus Rapid Transit (BRT)	• **Public Transport Department of GMMTA (when established)**
• BRT Road Development	• DMI Maputo, DMI Matola, ANE, Maputo Sul
• BRT Phase I	• New autonomous entity under the GMMTA
• BRT Phase II	• New autonomous entity under the GMMTA
• BRT Phase III	• New autonomous entity under the GMMTA
	Note: it may be possible to have all three BRT Phases under one IA
Conventional Bus	• **Public Transport Department of GMMTA (when established)**
• Capacity Building	• Maputo Councilor Traffic and Transport
• Network Design	• DMTT Maputo, DMT Matola
• Fleet Renewal	• Maputo Councilor Finance
• Transport Industry Restructuring	• Maputo Councilor Traffic and Transport
Traffic Management	• **Traffic Management Department of GMMTA (when established)**
• Traffic Flow Projects	• DMTT Maputo, DMT Matola
• Infrastructure Design/Modification	• DMI Maputo, DMI Matola
• Signal Control	• DMTT Maputo
• Software Projects	• DMTT Maputo, DMT Matola
• Enforcement and Training	• DMTT/Maputo Councilor Traffic and Transport

Abbreviations: ANE = Administração Nacional de Estradas (National Road Administration), BRT = bus rapid transit, DMI = Direcção Municipal de Infra-Estruturas (Directorate of Municipal Infrastructure), DMTT = Direcção de Serviço Municipal de Transportes e Trânsito (Directorate of Municipal Transport and Traffic), GMMTA = Greater Maputo Metropolitan Transportation Agency
Source: JICA Project Team

As indicated above, the IAs will draw on several resources for assistance including consultants, development lending agency personnel, and other municipal and national government entities. Government agencies that will provide significant inputs to implementation of the Master Plan include:

- National Directorate of Transport and Logistics, and the Department of Road Transport, Division of Road Transport for Passengers: These organizations have broad planning and policy roles related to road transport, will be sources of advice, and will monitor progress according to their responsibilities.
- Road Fund and FTC: These entities were organized for the purpose of accessing financing for transportation infrastructure in the Greater Maputo area and will be

instrumental in advising the IAs on financing issues as well as assisting in sourcing financing.

- Mozambique Ministry of Finance (MOF): The MOF is responsible for ensuring that the overall financing plan for the Master Plan is achievable and does not create unmanageable risks for Mozambique or communities in Greater Maputo. The MOF also manages the national budget process and has great influence over the allocation of national tax revenues to Master Plan projects. In addition, the MOF will advise the President of Mozambique on executing agreements with development financing agencies for Master Plan projects.
- Ministry of Public Works and Housing: This ministry will participate in its role as planner and manager of building and housing construction and as the agency that houses the Road Fund and ANE.
- ANE: The National Road Administration is responsible for the development of all national roads, including planning and policy functions. ANE is recommended as the IA for two road network projects.

12.3.4 Implementation of Commuter Rail Project

Among the Master Plan projects there may be the least amount of expertise within Mozambique or Greater Maputo for development and implementation of a suburban (commuter) rail system. It is recommended that a newly constituted autonomous entity under the GMMTA be established to implement suburban rail. It is also recommended that a private sector entity or entities be considered to implement the rail service. Significant areas that affect the rail Master Plan projects and will need to be effectively managed are listed in Table 12.5:

Table 12.5: Implementation Considerations and Recommendations for the Commuter Rail Project

Project Component	Key Considerations	Recommendations
Implementation organization	• Experience and expertise • Complexity • Cost • Need to consider private sector	• Consider long-term engagement of an international commuter rail specialist, preferably with executive management experience at a (significant) commuter rail agency
Land planning and preparation	• May be extensive considering track, stations, and depot(s)	• Begin scoping immediately • Communicate with the public • Draw on existing LARAP models
Private sector participation	• Interest already shown by the private sector • Need to understand opportunity and private sector motivation • Effective contracts and monitoring programs required	• Develop decision matrix – form of participation, objective (capital support, operating efficiency/cost control, risk transfer, financial support to private party) • Research arrangements and discuss with practitioners and potential investors through conferences and visits
System design	• Realistic view of ridership and capacity • Potentially complex signaling system	• Intensive ridership estimation – surveys, demand modeling, research into experience of other operators • Feasibility studies, operation simulations
Procurement	• Tender process perhaps more complex than experience • Costly, technical services • Potential development financing	• Research transactions, discuss with participants if possible • Request consideration from development financing organizations

Project Component	Key Considerations	Recommendations
Non-fare revenue	• TDR opportunities potentially significant • Need to secure available sites • Legal/regulatory changes may be needed	• Prepare rough drawing of ROWs • Survey ROWs to identify potential TOD sites • Determine ownership • Consider reserving ROWs if possible • Determine if legal changes are necessary
Managing operations	• Potentially high-volume, high activity • Cost control and safety critical • Customer experience key to success	• Intensive effort to estimate demand (noted above) • Engage experienced operators to design operating plan • Consider O&M contract with private company, such as an equipment supplier

Abbreviations: O&M = operations and maintenance, LARAP = Land Acquisition and Resettlement Action Plan, ROW = right of way, TDR = transfer of development rights
Source: JICA Project Team

12.4 Institute for Transport and Traffic Studies

12.4.1 Training Requirement

There is shortage of professionals in public and private organizations that could properly address transport and traffic issues in urban areas. Currently, higher education institutions such as UEM and ISUTC do not offer any relevant courses. The proposed Institute for Transport and Traffic Studies can be established within an existing higher education institution. Graduates of the proposed institute would work in central/local governments, state-owned enterprises, transport operating companies, and private consulting firms.

Disciplines in urban transport and traffic at typical western academic institutions include the following subjects in their curriculum:

- Comprehensive Transport Planning
- Demand Analysis and Modeling
- Urban Form (urbanization course)
- Traffic Signals
- Traffic Flow and Management
- Parking
- Transportation Systems Analysis
- Travel Behavior Analysis
- Bicycle and Pedestrian Planning
- Transportation Policy and Planning
- Transportation Economics, Finance, and Policy
- Transportation and Environmental Issues
- Special Topics in Transportation Policy and Planning

Some of the above subjects may be made optional based on the need of each trainee. Depending on the academic background of the trainees, more basic subjects may have to be included in the curriculum, including:

- Computing;
- Technology and Policy;
- Statistics;
- Economics;
- Town Planning; and
- Geographic Information Systems (GIS).

12.4.2 Forms of Training

In addressing training requirements, the following three forms of training may be considered:

a. Upgrading existing courses;
b. Offering a training course for working professionals; and
c. Establishing post graduate courses

Upgrading of existing courses (e.g., in civil engineering or architecture) at higher education institutions may be possible. In such instances, the training of lecturers may be required, and more generalized or introductory materials on urban transport planning may have to be developed to be "squeezed in" the existing curriculum, the time frame for which is usually already tight.

Training courses for working professionals in the public and private sectors should be designed to be offered within relatively a short period of time, e.g., 3–6 months, considering that the trainees (and employers) would like to minimize the time away from work during training courses. The time of day the training will be provided will also have to be determined carefully. In recruiting trainees, effective advertising/marketing to relevant public and private organizations will be essential.

Existing courses provided at higher education institutions could be extended to offer training courses leading to higher degrees (e.g., M.Sc., Ph.D.). The securing of qualified researchers and lecturers is a prerequisite to establishing such courses. Currently, higher degrees can only be obtained at overseas institutions, but if those degrees could be obtained in domestically, there would be potential to attract not only students within the country but also students from neighboring counties.

12.4.3 Capacity Development Project at ISUTC/UEM

Due to shortage of necessary skills and funding problems, external support will be required to these higher education institutions. Policies, Planning, and Research Department of GMMTA would provide opportunities for gaining practical experience for the students and lecturers at the institute which, in turn, provide opportunities to obtaining academic qualifications by the staff of the GMMTA. The proposed Capacity Development Project for ISUTC/UEM is described below:

Project Objectives: To strengthen the capacity of ISUTC/UEM in transport/traffic education training, and to establish:

- Courses for working professionals in the public and private sector (short courses)
- Transport and traffic courses within existing undergraduate and college courses
- Postgraduate (Master's degree) courses in transport and traffic studies

Implementing Agency: Maputo City, ISUTC/UEM

Project Period: 5 years

Outputs:

- Establishment of courses on transport planning/traffic engineering at ISUTC/UEM Self-sustainability of ISUTC/UEM in designing courses and recruiting students
- Familiarization of municipalities and provincial districts with the importance of staff training and/or hiring qualified transport/traffic professionals

- Dispatch of working professionals of private transport/traffic consultants to regularly update their skills
- Assistance by ISUTC/UEM in strengthening strategic institutions in the country in transport/traffic studies
- Establishment of a professional association in transport and traffic to exchange experience and create project synergies

Consultant Inputs:
- Team Leader
- Higher Education Course Design
- Transport Planning
- Traffic Engineering
- Additional short-term consultant to cover various subjects

Implementing Agency Inputs:
- Project Director
- Office space, local staff, seminar/workshop venues, domestic travel costs, and arrangement of scholarship for domestic students/trainees

Other points worth noting here include:

- The capacity development project could be implemented in two phases. During the first three years, development partner support would be provided intensively, and while over the next three years support could be intermittent.
- Training should be ideally provided in English to enable direct communication with external lecturers and to provide opportunities for students from neighboring countries such as Malawi and Zimbabwe.
- Assistance for graduates in finding jobs is required. Currently, there is a limited number of jobs available for graduates from higher education institutions in Mozambique, particularly for those graduates who majored, for example, in social sciences.
- One of the outcomes of the capacity development project could be the establishment of a professional association in transport and traffic. Such activity is important to increase the awareness of professional skills in transport and traffic disciplines. Involvement with the existing association of engineers in Mozambique may be helpful at outset.

12.5 Summary and Phasing

Table 12.6 summarizes the institutions and capacity development measures recommended in the short, medium, and long term. This requires close integration with all the remaining master plan project phasing.

Table 12.6: Phasing of Traffic Control, Management, and Safety Measures

Category	Code	Measure	Short Term	Medium Term	Long Term
Institutions and Capacity Development	IC1	Development of Metropolitan Greater Maputo Transport Agency (GMMTA)	✓		
	IC2	Capacity Development Project for ISUTC/ UEM	✓		

Source: JICA Project Team

Chapter 13 Master Plan Programs and Selection of Priority Projects

13.1 Master Plan Programs and Priority Projects

Upon careful analysis of existing traffic conditions in Greater Maputo and projections of traffic demand up to 2035, a Master Plan with short, medium, and long-term projects was outlined in the previous chapters.

Table 13.1 provides a summary of the Master Plan with the proposed projects grouped into four broad categories (called "programs" in the table). These programs are major areas where development should be undertaken in the coming twenty years, including: (i) Maputo–Matola (East-West Axis) Transport Development; (ii) North-South Axis Transport Development; (iii) Traffic Management and Related Measures in and around CBD; and (iv) Capacity/Institutional Development. Each program, briefly described in the "Program" column, consists of short, medium, and long-term development initiatives and projects. "Primary Development Initiatives" in the table indicate major elements of the projects to be implemented in each phase; these projects are those presented in the previous chapters and described concisely under the primary development initiatives. Table 13.1 provides a comprehensive view of the Master Plan.

Among the projects in the Master Plan, priority projects were selected based on the criteria in the section that follows. The selection process identified several projects that should be implemented urgently in the short-term period to fulfill short-term transport needs and contribute to public transport-oriented planning.

Table 13.2 provides a list of the priority projects selected based on the scoring set out in Section 13.2. These were presented as priority projects during the steering committee meeting held in March 2013 on the subject of the interim report. In Table 13.2, the priority projects are grouped according to the four programs mentioned above. The location of the priority road, rail, and BRT projects is illustrated in Figure 13.1. The numbers of the projects indicated in the "short-term" column of Table 13.1 (e.g., #1, #2) correspond to the numbers of the priority projects listed in Table 13.2.

Table 13.1: Master Plan Programs with Proposed Phasing

Program		Urgent (Short Term) (2018)	Medium Term (2025)	Long Term (2035)
Maputo-Matola (East-West Axis) Transport Development: ✓ Introduce mass transit systems (Commuter Rail and BRT) with transit-oriented development ✓ Develop Commuter Rail and BRT with phasing ✓ Improve transport systems for Matola suburban and industrial development and for sustainable metropolitan growth ✓ Consider interregional as well as intra-urban transport network		**Primary Development Initiatives** ✓ **Urgent major capacity expansion along the axis** ✓ **Preparation for commuter rail development** ✓ **Transport improvement for Matola suburban and industrial development** Road • Major district roads linking Maputo and Matola (#1, 2) including an exclusive busway; Matola industrial area major arterial roads (#3); N4 widening; reconstruction of Boane Bridge (# 5) Public Transport • Preparation for the development of Maputo-Matola Gare Rail Line (#4) • The above-mentioned exclusive busway to link Maputo and Matola	**Primary Development Initiatives** ✓ **Continued capacity expansion along the axis** ✓ **Mass transit systems development including: (i) commuter rail with transit-oriented development (TOD), and (ii) BRT** ✓ **Local mobility upgrading measures** Road • Improvement for BRT (3 major routes/sections) • Inner ring road; other major district roads; major distributors Public Transport • Maputo-Matola Gare Line • BRT (3 major routes/ sections)	**Primary Development Initiatives** ✓ **Transport infrastructure development for sustainable metropolitan growth with decentralized population** ✓ **Continued development of mass transit systems (toward suburban areas)** Road • Outer ring road extension; N2 widening (southwest); arterial roads for suburban development • Improvement for BRT extension Public Transport • BRT extension • Machava-Boane Rail Line
North-South Axis Transport Development ✓ Introduce mass transit systems, developing BRT in short to medium term and Commuter Rail in the long term ✓ Develop BRT with phasing ✓ Improve transport systems for better accessibility between Maputo and Marracuene and for sustainable metropolitan growth ✓ Align transport development with environmental improvement along the coastline		**Primary Development Initiatives** ✓ **Major capacity expansion along the axis with mass transit systems development (BRT for the North-South axis)** ✓ **Accessibility improvement between Maputo and Marracuene**	**Primary Development Initiatives** ✓ **Continued capacity expansion along the axis with BRT** ✓ **Local mobility upgrading measures** ✓ **Environmental improvement along the coastline**	**Primary Development Initiatives** ✓ **Transport infrastructure development for sustainable metropolitan growth with decentralized population** ✓ **Continued development of mass transit systems (toward suburban areas)**
	East	Road • Improvement for BRT (#6) • Maputo-Marracuene (#9) Public Transport • BRT (Baixa – Maganine) (#6)	Road • Improvement for BRT (Julius Nyerere Line) • Other major arterial roads; major district roads; major distributors • Costa do Sol area roads Public Transport • BRT (Julius Nyerere Line)	Road • Arterial roads for suburban development • Improvement for BRT extension Public Transport • BRT extension • Maputo-Marracuene Rail Line
	West	Road • Improvement for BRT (#7); N1 bypass construction (#8) Public Transport • BRT (Zimpeto-Benfika-Brigada) (#7)	Road • Other major arterial roads; major district roads; major distributors	Road • Arterial roads for suburban development • Improvement for BRT extension Public Transport • BRT extension
Traffic Management and Related Measures in and around CBD ✓ Remove major bottlenecks in short term and implement TDM measures in medium to long term ✓ Upgrade traffic signal system in stages ✓ Implement related urgent measures in short term and move toward greater control or enforcement of related regulations		**Primary Development Initiatives** ✓ **Short-term traffic management measures for major bottlenecks** ✓ **Initial phase of upgrading traffic signal system** • Improvement of bottleneck intersections (#10) • Measures for major bottlenecks (#11), e.g., bus priority, one-way • Short-term traffic signal measures (#12), e.g., warrants for signals, addressing right turn problems at critical junctions, start operating the Operational Control Centre (CCO) • Traffic safety and related measures (#13), e.g., digital traffic accident database, safety measures at accident hotspots, better driver training and education, addition of new on-street parking areas	**Primary Development Initiatives** ✓ **Medium-term traffic management measures** ✓ **Expansion of traffic signal system** ✓ **Greater control/enforcement of related regulations** • Implementation of high occupancy vehicle (HOV) lanes • Full operation of CCO; implementation of Adaptive Signal Control (ASC) system; medium-term traffic signal expansion • Other related measures, e.g., greater control of fleet, electronic safety enforcement, further increase in on-street parking areas, control of sidewalk parking	**Primary Development Initiatives** ✓ **Traffic Demand Management (TDM) measures** ✓ **Contineud expansion of traffic signal system** • TDM measures (traffic-related), e.g., private vehicle restrictions (using license plates to control circulation), parking control regulations, car-pooling, HOV lanes • TDM pricing measures, e.g., higher parking charges, tolls, vehicle ownership taxes/fees, fuel tax • Continued expansion of traffic signals
Capacity / Institutional Development ✓ Develop capacity of the public transport sector in short term, restructure the sector in medium term, and achieve its financial sustainability in long term ✓ Establish effective Greater Maputo urban transport institution (i.e., GMMTA) in medium term		**Primary Development Initiatives** ✓ **Capacity building in urban transport sub-sectors** ✓ **Preparation for establishing effective Greater Maputo urban transport institution** Public Transport • Capacity building of TPM and improvement of chapa services (#14); bus network design (including feeder services) and fleet renewal (#15) • Capacity building for mass transit systems (Commuter Rail and BRT) Urban Transport Institution • Initiating activities to establish GMMTA (#17) Road • Capacity strengthening for road maintenance (#16)	**Primary Development Initiatives** ✓ **Restructuing of Public Transport Industry** ✓ **Establishment of effective Greater Maputo urban transport institution** Public Transport • Restructuring of the public transport industry; continued improvement of bus network (including feeder services) and bus fleet • Upgrading of mass transit systems operation (Commuter Rail and BRT) Urban Transport Institution • Establishment of GMMTA and capacity building for its effective operation • Establishment of an institute for transport and traffic studies (within an existing educational institution)	**Primary Development Initiatives** ✓ **Achievement of financial sustainability in public transport sector** ✓ **Application of Maputo experience to other cities** Public Transport • Measures to achieve financial sustainability of public transport systems including public bus, Commuter Rail, and BRT Traffic Management • Implementation of TDM measures, thereby controlling urban transport demand cost-effectively and increasing revenues usable for urban transport management

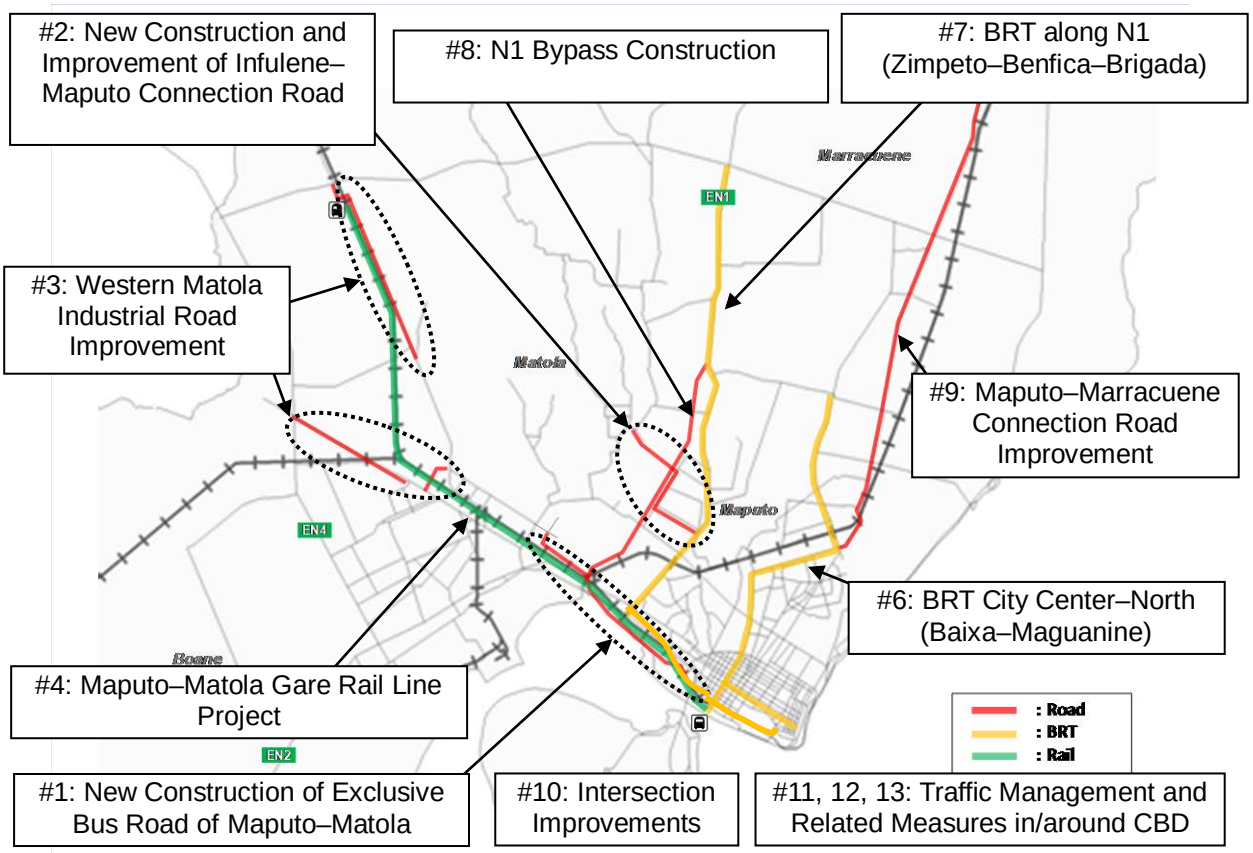
Abbreviations: BRT = Bus Rapid Transit, GMMTA = Greater Maputo Metropolitan Transport Agency, TDM = Traffic Demand Management
Note: The numbers indicated in the short-term initiatives column correspond to the numbers of the priority projects listed in Table 13.2.
Source: JICA Project Team

Table 13.2: List of Priority Projects

No	Project	Sub-sector	Description	Length (km)	App. Cost (USD million)	Remarks
	East-West Axis					
1	New Construction of Exclusive Bus Road of Maputo–Matola	Road	To construct an exclusive busway to link Infulene (in Matola) and Maputo using the ROW of the railway	7.2	20.8 (Lower cost case: 13)	• To reduce congestion along the most heavily traveled route in Greater Maputo within a short period of time • Some resettlement required.
2	New Construction and Improvement of Infulene–Maputo Connection Road	Road	To construct (and partially improve) a major district road to link Infulene (in Matola) and Maputo	5.7	8.0	• To reduce congestion in Matola–Maputo and promote inter-district movements of people and goods
3	Western Matola Industrial Road Improvement	Road	To pave a major arterial road in the Western Matola industrial area	11.6	17.6	• To promote industrial development and multi-core urban structure
4	Preparation for Maputo–Matola Gare Rail Line Project	Rail	To conduct project preparation for Maputo–Matola Gare Rail Line to be developed by medium-term period (using the existing railway ROW)	20	650 (Lower cost case: App. 450) (Note that both cases are with electrification.)	• To reduce congestion along the most heavily traveled route in Greater Maputo as well as promote rail-oriented urban development and multi-core urban structure potentially with public-private partnership (PPP) • The project will require some resettlement of those living within the existing railway ROW.
5	Reconstruction of Boane Bridge	Bridge	To reconstruct a bridge in Boane crossing Umbulzi River that collapsed in January 2012	0.6	10.6	• For recovery from the disaster and for elimination of the areas adversely affected by the collapse
			Subtotal	**45.1**	**499.2~707**	
	North-South Axis					
6	BRT City Center–North (Baixa–Maguanine)	Road	To improve related Av. Eduardo Mondlane	2.6	5.9	• Improvement (mainly widening) along the BRT route
		Road	To improve other related roads	12.4	25.7	• Improvement (mainly widening) along the BRT route
		BRT	To develop BRT from the city center toward north (Baixa–Maguanine)	12.9	136	• Expected to be undertaken with loan funds from Brazil • Small-scale resettlement required
7	BRT along EN1 (Zimpeto–Benfica–Brigada)	Road BRT	To improve the related section of EN1 and develop BRT from Zimpeto to Brigada via Benfica along EN1	19.1	93.0	• Road improvement (mainly widening) along the BRT route • No significant environmental and social impacts expected
8	EN1 Bypass Construction	Road	To construct a bypass for EN1 along the Greenbelt, and link EN1 with EN4	8.3	154 (Lower cost case: App. 90)	• To reduce congestion, separate between through and local traffics, and provide better EN1 BRT service • Some resettlement required, and some agricultural land to be affected.
9	Maputo–Marracuene Connection Road Improvement (A)	Road	To pave Av. Cardeal Alexandre dos Santos linking Marracuene and Maputo, and absorb traffic from the BRT Line (city center–north)	19.3	28.6	• To reduce congestion, ensure traffic safety, and promote development toward Marracuene • Some resettlement required
			Subtotal	**74.6**	**379.2～443.2**	

No	Project	Sub-sector	Description	Length (km)	App. Cost (USD million)	Remarks
	Traffic Management					
10	Intersection Improvements	Traffic Mgmt	To improve configurations of bottleneck intersections for smooth traffic flow	NA	10.5	• Implementation under the grant aid scheme is recommended.
11	Short-Term Traffic Management Measures	Traffic Mgmt	To remove bottlenecks impeding smooth traffic flow	NA	10	• The measures include bus priority, one-way systems, banning of right turns, etc.
12	Traffic Signal Measures	Traffic Mgmt	To increase traffic signal installations, and introduce traffic signal control system	NA	50	• It will be effective to use Intelligent Transport Systems (ITS) for the control system to be introduced.
13	Traffic Safety Measures	Traffic Mgmt	To implement short-term measures for traffic safety improvements	NA	7	• The measures include digital database development, better driver training and education, and pedestrian measures. • Implementation under the technical cooperation project scheme is recommended.
			Subtotal		**77.5**	
	Capacity/Institutional Development					
14	Capacity Building of the Bus Sector	Bus	To strengthen operational capability of TPM, and help improve bus and *chapa* services	NA	5	• Implementation under the technical cooperation project scheme is recommended. As part of TPM strengthening, the project may include assistance for restructuring bus and *chapa* network, service improvement, fare restructuring, common tickets, and reorganizing the locations of bus terminals.
15	Improvement of Bus Sector	Bus	To restructure the bus network (including feeder services) and renew bus fleet	NA	80	• Combination of technical and financial assistances is recommended. The network design should aim at developing an effective feeder routes for rail and BRT systems as well as covering areas where mass transit routes would not be able to serve effectively.
16	Road Maintenance Capacity Strengthening Project	Road	To strengthen the capacity for road maintenance in Greater Maputo	NA	3	• Implementation under the technical cooperation project scheme is recommended. Improvement of road inventory, introduction of HDM4, and securing road maintenance budget should be part of the project.
17	Development of Greater Maputo Metropolitan Transport Agency (GMMTA)	Urban Transp	To establish an organization to strengthen coordination and decision making for the transport development in Greater Maputo	NA	3	• Implementation under the technical cooperation project scheme is recommended. The project should assist the establishment of GMMTA with statutory power of decision that ensures prioritization and implementation. • Initially, the project is to strengthen the capacity of the existing DMTT of Maputo Municipality that would be a core of the GMMTA to be established. • This project is also to develop a project performance monitoring system (PPMS) for the entire Master Plan and assist its implementation.
			Subtotal		**91**	
			Total	**119.7**	**1,046.9～1,318.7**	

Source: JICA Project Team



Note: The map shows the proposed priority projects #1–#13 except for #5 Reconstruction of Boane Bridge which is located outside of the above map, toward southwest along N2.
Source: JICA Project Team

Figure 13.1: Map of Priority Projects

13.2 Criteria for Selecting Priority Projects

The projects proposed in the preceding chapters (the Master Plan projects) were prioritized based on common criteria applied across projects in different sub-sectors. Three measures, "Urgency", "(Potential) Effect", and "Implementability", were used. These factors are particularly important to select the projects that will cost-effectively achieve the urban transport development vision and strategies set out in the Master Plan.[1]

For each factor, a score of '1', '2', or '3' was given to the projects based on the evaluation criteria specified in Table 13.3.

[1] As of March 2013, the JICA Project Team proposed six measures including Relevance, Urgency, Effectiveness (potential), Efficiency, Sustainability, and Impact, based on which a preliminary selection of priority projects was undertaken. It was however considered that using these measures, which are the DAC criteria for evaluating development assistance (except for Urgency), makes the process difficult to understand due to its complexity, and was not quite suited to this selection. Based on the reexamination of the selection process, the JICA Project Team used the three measures mentioned above, which allows for effective comparison of the Master Plan projects while avoiding complexities in the selection process. This change did not affect the selection; the priority projects selected above are the same as those based on the previous measures, i.e., those presented during the steering committee meeting held in March 2013.

Table 13.3: Evaluation Criteria for Priority Projects

Measure		Criteria
Urgency	3:	Projects that should be implemented immediately in order to address the major transport issues/challenges identified in Chapter 2, and/or are a prerequisite for other projects to be urgently implemented. These projects include those in line with the major development initiatives identified in Section 5.3
	2:	Projects whose implementation is relatively less urgent, and/or cases where there are other related projects that should be implemented first
	1:	Projects that will address a long-term issue rather than a short- or medium-term issue, thus judged not particularly urgent
Effect (potential)	3:	Projects that will contribute cost-effectively to an increase in the use of public transport and/or reduction in traffic congestion, thus bringing benefits to transport users, or projects that are deemed to be cost-effective with a relatively small investment to achieve the overarching urban transport development strategies
	2:	Projects that are relatively less cost-effective, and/or projects for which alternative measures (e.g., alternative routes) are available
	1:	Projects that are the least cost-effective among the proposed projects, and/or projects whose feasibility is deemed to be very uncertain
Implementability	3:	Projects that would involve no major difficulty or uncertainty/risks in terms of project preparation, implementation, operation, management, and maintenance
	2:	Projects that may involve some difficulty or uncertainty/risks in terms of project preparation, implementation, operation, management, or maintenance
	1:	Project that are likely to face major difficulty in terms of project preparation, implementation, operation, management, or maintenance

Source: JICA Project Team

13.3 Scoring of Master Plan Projects

Table 13.4 to Table 13.6 present the scoring for the proposed Master Plan projects for public transport, roads, and traffic management. An overall score was calculated as a weighted average of the scores for the three measures with the weight being 0.4 for both “Urgency” and “Effect” and 0.2 for “Implementability” considering that the first two measures should be relatively more important.

Projects with an overall score equal to or more than 2.8 are selected as priority projects.

Table 13.4: Scoring of Master Plan Projects (Public Transport)

Category	Project	Criteria			Overall Score	Priority Project
		Urgency	Effect	Imple-mentability		
Passenger Rail	**Maputo–Matola Gare Line**	3	3	2	**2.8**	✓
	Maputo–Marracuene Line	1	2	2	1.6	
	Machava–Boane Line	1	2	2	1.6	
BRT	**Baixa–Maguanine via Xiquelene, Praca dos Herois**	3	3	2	**2.8**	✓
	Zimpeto–Benfica–Brigada	3	3	2	**2.8**	✓
	Malhampswene–Ceres–Baixa	2	3	2	2.4	
	Casa Branca–Joaquim Chissano–Julius Nyerere	2	3	2	2.4	
	Xiquelene–Museu–Baixa	2	2	2	2.0	
	Albasine via Cardeal A Santo (BRT 1 Extension)	1	1	2	1.2	
Conventional Bus	Restructuring of the public transport industry	2	3	2	2.4	
	Capacity building of the bus sector	3	3	2	**2.8**	✓
	Bus network design (including feeder services)	3	3	2	**2.8**	✓
	Bus fleet renewal	3	3	2	**2.8**	✓
Supporting Infrastructure and Measures	Intermodal stops, hubs, and interchanges	2	3	2	2.4	
	Integrated walking and cycling network	2	3	2	2.4	
	Complementary measures (information, marketing, ticketing)	2	3	2	2.4	
	Development of Greater Maputo Metropolitan Transport Agency (GMMTA)	3	3	2	**2.8**	✓

Note: Overall Score = Urgency*0.4 + Effect*0.4 + Implementability*0.2
Source: JICA Project Team

Table 13.5: Scoring of Master Plan Projects (Roads)

Category	Project	Criteria			Overall Score	Priority Project
		Urgency	Effect	Imple-mentability		
Major Maputo North–South Arterial Roads	Construction of airport-side North–South route	2	2	2	2.0	
	Eastern Airport North–South route improvement	2	3	2	2.4	
	Four-lane widening of Maputo central urban area major arterial road	2	3	1	2.2	
	Maputo–Marracuene connection road improvement (A)	3	3	2	**2.8**	✓
	Improvement of Maputo–Marracuene connection road (B)	2	1	3	1.8	
	Julius Nyerere flyover	2	2	2	2.0	
Ring Roads and Major East–West Arterial Roads	Construction of inner ring road	2	3	1	2.2	
	Construction of Boane outer ring road and EN2 widening	1	2	2	1.6	
Western Matola Industrial Area Major Arterial Roads	**Industrial road improvement**	3	3	2	**2.8**	✓
	EN4 widening	3	3	1	2.6	
National Roads and Other Major Arterial Roads	**Construction of EN1 bypass construction**	3	3	2	**2.8**	✓
	Reconstruction of Boane Bridge	3	3	3	**3.0**	✓

Category	Project	Criteria			Overall Score	Priority Project
		Urgency	Effect	Imple-mentability		
District Arterial Roads and Main Streets	New construction and improvement of Nhlamankulu area route	2	3	1	2.2	
	Eastern airport urban area route improvement	2	2	2	2.0	
	Northern Maputo East–West route improvement	2	2	2	2.0	
	Infulene urban area road improvements	2	3	3	2.6	
	New construction and improvement of roads in the Machava urban area	2	3	1	2.2	
	New construction and improvement of roads in the Matola suburban area	2	2	2	2.0	
	Improvement of Matola–Sede urban arterial road	2	3	3	2.6	
	KaTembe R403 improvement	2	2	3	2.2	
Distributor Roads	Four-lane widening of Maputo central urban area peripheral road	2	2	3	2.2	
	Western airport area route improvement	2	2	2	2.0	
	New construction and improvement of greenbelt road	2	2	2	2.0	
	Construction of the Matola power cable line extension	2	2	3	2.2	
District Connection Roads	New construction and improvement of Machava–Maputo connection road	2	3	2	2.4	
	New construction and improvement of Infulene–Maputo connection road	3	3	2	**2.8**	✓
	Northern Infulene–Maputo connection road improvement	2	2	3	2.2	
	Exclusive bus road of Maputo–Matla new construction	3	3	2	**2.8**	✓
Arterial Road for Land Use Development	Construction of the Costa do Sol area road network for district development	2	2	1	1.8	
	Construction of the Northern Matola road for district development	1	1	2	1.2	
	Construction of the Marracuene East–West route	1	1	2	1.2	
	Construction of the Boane connection for district development	1	1	2	1.2	
	Construction of the Boane–KaTembe connection for district development	1	1	3	1.4	
BRT-related Road Improvements	**BRT Maputo central urban line (Baixa–Maguanine via Xiquelene, Praca dos Herois)**	3	3	2	**2.8**	✓
	BRT Maputo North–South line (Baixa–Maguanine via Xiquelene, Praca dos Herois)	3	3	2	**2.8**	✓
	BRT EN1 line (Zimpeto–Benfica–Brigada)	3	3	2	**2.8**	✓
	BRT Julius Nyerere line	2	2	2	2.0	
	Av. Coronel General Sebastião Mabote	1	1	2	1.2	
	BRT Maputo Machava East–West line	2	3	2	2.4	
	BRT Maputo Matola Sede line	2	3	2	2.4	
	BRT Matola EN4 Line (South)	2	3	2	2.4	
	BRT Matola EN4 Line (North)	2	3	2	2.4	

Category	Project	Criteria			Overall Score	Priority Project
		Urgency	Effect	Imple-mentability		
Capacity Development	**Road maintenance capacity strengthening project**	3	3	2	**2.8**	✓
	Drainage system technical cooperation project	3	3	2	**2.8**	✓

Note: Overall Score = Urgency*0.4 + Effect*0.4 + Implementability*0.2
Source: JICA Project Team

Table 13.6: Scoring of Master Plan Projects (Traffic Management)

Category	Project	Criteria			Overall Score	Priority Project
		Urgency	Effect	Imple-mentability		
Intersection Improvements	**Intersection improvements**	3	3	3	**3.0**	✓
Short-Term Traffic Management Measures	**Public transport priority/ improvements package**	3	3	3	**3.0**	✓
	Improved access to new suburbs ("Bairros Populares") along the main highways	3	3	3	**3.0**	✓
	Short-term road development and urban structuring measures	3	3	3	**3.0**	✓
	Linking of new projects with the existing road network	3	3	3	**3.0**	✓
Traffic Signal Measures	**Warrants for signals**	3	3	2	**2.8**	✓
	Package of conflicting right-turn schemes	3	3	2	**2.8**	✓
	Area traffic signal control system	3	3	2	**2.8**	✓
	Medium-term expansion of traffic signals	3	3	2	**2.8**	✓
	"Bilateral" agency agreements on maintenance/timings	3	3	2	**2.8**	✓
Traffic Accident and Road Safety Measures	Electronic enforcement	2	2	2	2.0	
	Pedestrian measures at accident hotspots	3	3	3	**3.0**	✓
	Digital database	3	3	2	**2.8**	✓
	Alcohol-related measures	2	3	2	2.4	
	Better driver training and education	3	3	2	**2.8**	✓
	Greater control of the fleet	2	3	2	2.4	
Parking	Expansion of the rotativo system	2	3	3	2.6	
	Special access and other reserved bays	2	3	2	2.4	
	Sidewalk parking	2	3	2	2.4	
	Parking regulations	2	3	2	2.4	
Traffic Demand Management (TDM)	High-Occupancy Vehicle (HOV) lanes	2	3	2	2.4	
	Increase in the supply of short-term parking	2	3	2	2.4	
	Better quality public transport	3	3	2	**2.8**	✓
	Controls over road taxes and fines	2	3	2	2.4	

Note: Overall Score = Urgency*0.4 + Effect*0.4 + Implementability*0.2
Source: JICA Project Team

13.4 Priority Projects

Table 13.7 lists the priority road projects, while Table 13.8 lists the priority public transport and other projects and programs. A comprehensive list of the priority projects is presented in Table 13.2, and the location of the priority road, rail, and BRT projects illustrated in Figure 13.1.

Table 13.7: Road Projects

Category	Project	Route	Length (km)	Project Cost (USD million)
Road Construction	Maputo–Marracuene Connection Road Improvement (A)	• Av. Cardeal Alexandre dos Santos • Rua 4.665	19.3	28.6
	Industrial Road Improvement	• Rua 21.115, Rua 21.142 • Av. das Industrias • R807 (Av. Josina Machel)	11.6	17.6
	Construction of EN1 Bypass	• New EN1 Bypass	8.3	153.7
	Boane Bridge Reconstruction	• N200 (Boane Bridge)	0.6 (0.15)	10.6
	New Construction and Improvement of Infulene–Maputo Connection Road	• Rua 5.260 • Rua 5.315 • Rua 31.286	5.7	8.0
	Construction of Exclusive Maputo–Matola Bus Road	• Maputo–Matola (railway side)	7.2	20.8
Road Widening and Related Works	Maputo Central BRT Urban Line	• Av. Eduardo Mondlane	2.6	5.9
	Maputo BRT North–South Line	• Av. Guerra Popular • Av. Acordos de Lusaka • Av. das FPLM • Av. Julius Nyerere	12.4	25.7
	BRT EN1 Line	• EN1 (South) • EN1 (North)	19.1	38.8

Source: JICA Project Team

Table 13.8: Public Transport and Other Projects/Programs

Project Component	Projects/Programs	Components	Length (km)	Project Cost (USD million)
BRT	Higher-Priority Routes	• Baixa–Maguanine via Xiquelene, Praca dos Herois	12.9	136
		• Zimpeto–Benfica–Brigada	19.1	54.2
Commuter Rail	Priority Section	• Maputo–Matola Gare Line	20	650
Intersection Improvements	Intersection Improvements	• Improvement of bottleneck intersections	NA	10.5
Traffic Management	Short-term Management Measures	• Bus priority/One-way system/ traffic flow improvements at bottlenecks	NA	10
Traffic Signal Measures	Short-term Traffic Signal Measures	• Increasing traffic signal installations and introduction of traffic signal control system	NA	50
Traffic Safety Measures	Short-term Traffic Safety Measures	• Digital database development, better driver training and education, pedestrian measures	NA	7

Project Component	Projects/Programs	Components	Length (km)	Project Cost (USD million)
Institutions and Capacity Development	Capacity Building of the Bus Sector	• Strengthen operational capability of TPM and help improve bus and chapa services	NA	5
	Improvement of the Bus Sector	• Bus network restructuring (including feeder services) • Bus fleet renewal	NA	80
	Road Maintenance Capacity Strengthening Project	• Road maintenance capacity strengthening including improvement in drainage system management	NA	3
	Development of Greater Maputo Metropolitan Transport Agency (GMMTA)	• Support for the development of the GMMTA • Develop project performance monitoring system (PPMS) for the entire Master Plan	NA	3

Source: JICA Project Team

Box 13.1: An Example of Urgent Projects – Intersection Improvements

(1) Overview

There are priority projects that should be implemented urgently while requiring a relatively low level of capital investment. One such project is the improvement of bottleneck intersections, which is proposed as part of the priority traffic management projects. Potential components of the project are as follows:

- Redesign and improvement works of major bottleneck intersections in Maputo City (e.g., about five locations, possibly including the intersections for which improvement measures are proposed in this master plan study)
- Rehabilitation of drainage for these intersections

The implementing agency for the project is expected to be the Municipal Council of Maputo. It is recommended that external assistance for this urgent project should be sought if the fund from domestic sources is not sufficient.

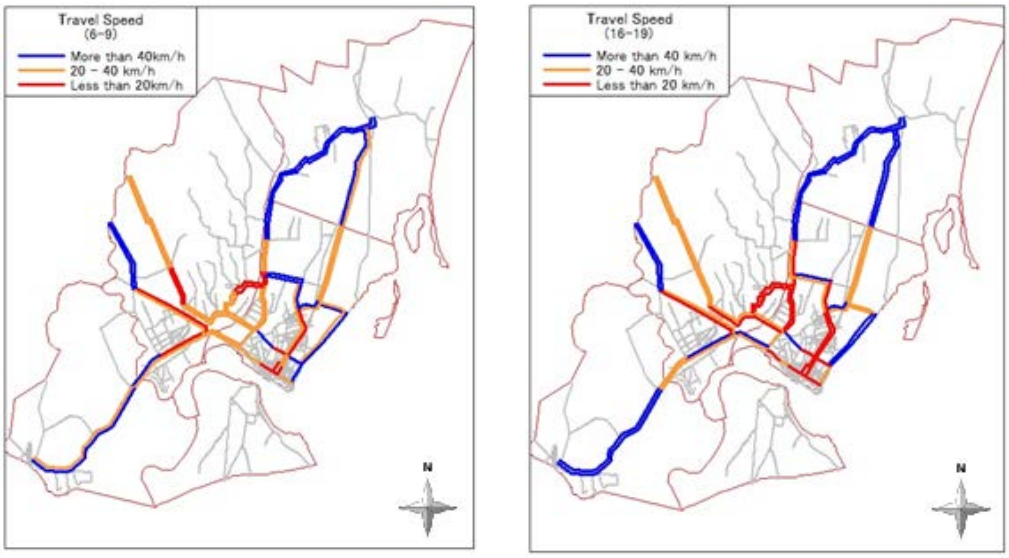
(2) Need for the Project

During this master plan study, traffic bottlenecks and accident hotspots were identified as shown in Figures 2.8 and 2.9 in Chapter 2 of this report. Many of these bottlenecks are located along the proposed short-term BRT projects (including the N1 BRT and the Maputo North-South BRT Line), and any physical improvement in these bottlenecks should be undertaken after a detailed BRT plan is developed.

There are also bottleneck intersections that worsen the congestion along major arterial roads during peak hours and are located outside of the short-term BRT projects. Such intersections may include: N2–Rua Do Jardim (Bananeiras highway access); Rua Do Jardim–Av. das Industrias; and Joao Mateus Intersection along N2 (see Figures 2.8 and 2.9). The first two intersections are located at a place where three major roads along the East-West Axis are concentrated (i.e., N2, Av. das Industrias, and Rua Do Jardim). As shown in the figure below, the sections of these roads around the two intersections are severely congested during peak hours, and as traffic grows, the state of congestion will worsen unless appropriate traffic management measures including the intersection improvement are undertaken. In addition, the Joao Mateus Intersection handles the traffic between the center of Matola City and

Maputo and between Boane and Maputo, both running on N2, and will be a major bottleneck of N2 unless appropriate treatment is made.

Improvement of these intersections can be implemented as a project independent of any short-term BRT project, and will contribute to reducing congestion and traffic accidents on these important roads along the East-West Axis.



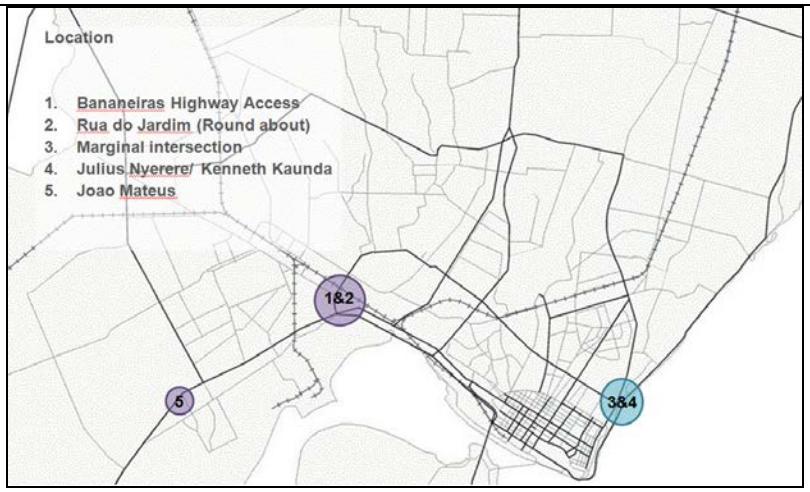
Morning (6AM to 9AM) **Evening (4PM to 7PM)**

Results of Travel Speed Surveys

It is also effective to improve bottleneck intersections that are related to the proposed short-term BRT projects. Such intersections may include those related to Av. Julius Nyerere, part of which is included in the Maputo North-South BRT Line Project (up to the intersection with Av. F.P.L.M). With BRT development, the traffic on Av. Julius Nyerere that is already congested during peak hours will increase further, requiring smooth traffic operation on related sections as well. There are important intersections requiring improvements that are located along the coast (not on the planned BRT route) and provide a connection to Av. Julius Nyerere. These intersections include those indicated as 3 and 4 in the map below, which also handle traffic to and from the Maputo CBD. Improvement of these intersections can be implemented without influence of any short term BRT project, and will bring an immediate effect to smoothen traffic to/from the Maputo CBD even prior to BRT development. Improving these intersections will also contribute to creating better landscape along the coast.

(3) Potential Target Intersections

The intersections described above can be a potential target by a short-term intersection improvement project, which include those shown in the following map:



Locations of Major Bottleneck Intersections

Major issues and potential measures and effects for each location are described below.

1) Bananeiras Highway Access

This interchange has an extraordinary shape compared with usual handling of traffic from a trunk highway to an ordinary road by a loop ramp shown by a large circle. Direct connection to a small roundabout though it provides an easier connection leading to Av. Industrias created a traffic bottleneck. Besides, the conflict at an intersecting point of both loops would cause not only traffic congestion but also increase possibility of accidents. When a small loop is enlarged the intersecting point becomes a weaving section, although the distance is not long enough to handle a large number of traffic, this improvement will contribute to traffic accident reduction and smooth traffic movement without installing a traffic signal.

Expected works at this specific location would be removal of existing round about, new construction of road bed as well as a pavement, drainage reconstruction, traffic sign installation, setting curbstone and marking. Temporary construction of the road for detour of traffic during construction will be necessary.

This intersection provides connection to N2 that has the highest traffic volume in Greater Maputo. The traffic counts conducted during the study included a location along N2 (at A1 screenline location) with about 34,000 vehicles per day (vpd) (see Table 2.8 in Chapter 2 of this report). While the traffic volume using this interchange was not counted, considerable improvement can be expected in congestion and traffic safety.

Bananeiras Highway Access: Possible Solution with Roundabout Improvement

2) Rua do Jardim (Round about)

This specific location is considered to be a three-leg intersection without a signal control. Av. Industrias attracts heavy truck traffic which needs a big shape intersection for turning. When a roundabout which can negotiate turning of a large truck is constructed, the traffic flow become much smoother.

Expected works at this specific location would be removal of existing islands for channelization, widening of the corner, new construction of road bed as well as a pavement, drainage reconstruction, traffic sign installation, setting curbstone and marking. Traffic management of the existing traffic during construction will be necessary.

This intersection was included in the junction surveys conducted during the study (at J2 survey point), indicating that the number of vehicles entering the junction was 27,672 vpd with trucks accounting for 13%, which was the highest proportion among all of the junction survey points (see Table 2.5 in Chapter 2 of this report). This improvement will lead to a smooth movement of large size vehicles that will reduce congestion along these roads as well as improve safety at the intersection.

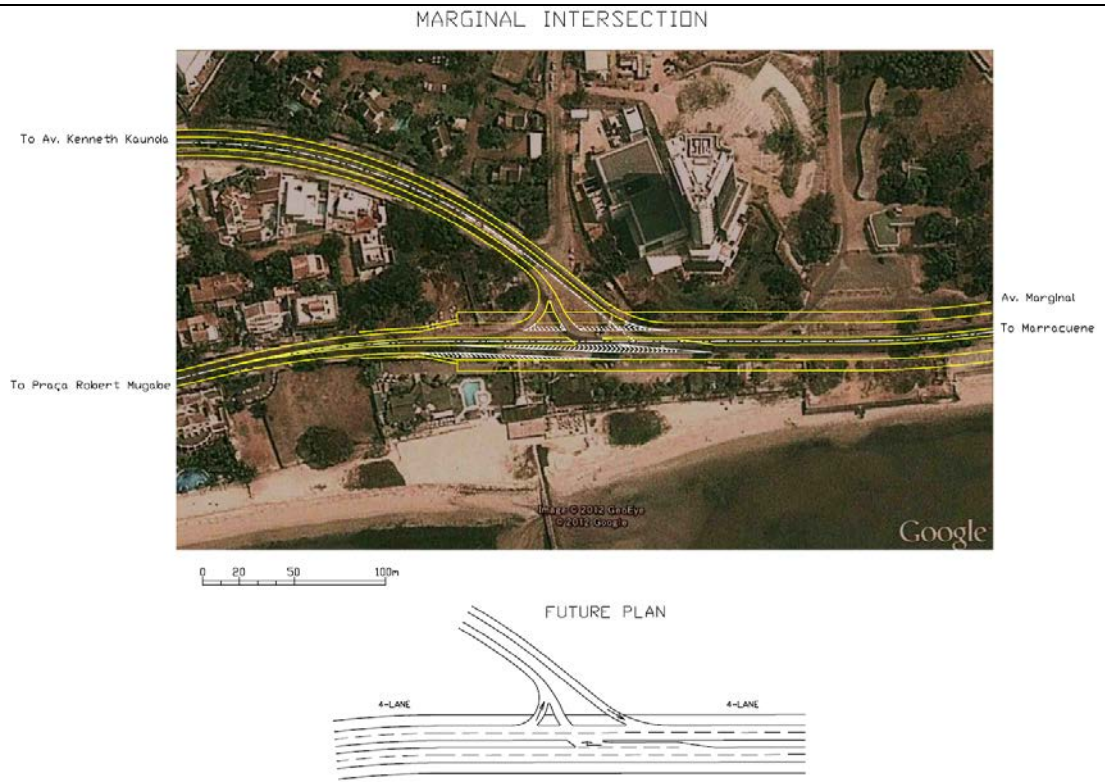
Av. Indústrias Access at Rua do Jardim: Solution with Roundabout

3) Marginal Intersection

This intersection is a connection of the roadway from Av. Julius Nyerere and Av. Marginal. The shape of intersection is a little complicated and cause disturbance to the traffic and hazard of safety. The measures to improve include a simplified intersection with signal control so that there will be no conflicts of traffic movement and thus maintain smooth traffic flow and safety.

Expected works at this specific location would be removal of existing markings, widening of the corner, new construction of road bed as well as a pavement, drainage reconstruction, traffic sign and signals installation, sidewalk installation, setting curbstone and marking. Traffic management of the existing traffic and temporary road during construction will be necessary.

This intersection was included in the junction surveys conducted during the study (at J8 survey point), indicating that the number of vehicles entering the junction was about 5,000 vpd with a significantly high proportion of cars and taxis (90%). This reflects the land use pattern along the coast where high-end residential development has taken place. With the development of the Maputo North-South BRD Line that will include part of Av. Julius Nyerere as well as further residential and tourism development along the coast, the traffic at this intersection is expected to grow further, thus the benefit of this improvement will be significant.



Marginal Intersection: Possible Improvement

4) Julius Nyerere/ Kenneth Kaunda

This round-about location is very crowded with a lot of traffic especially peak periods. The oval shape roundabout has a limit to handle these peak traffic volumes without signal control. The proposed solution to this roundabout intersection is to separate traffic flow directions as much as possible reduce the number of conflicts and make the flow in the intersection simple. The expected preliminary design is similar to the shape of deformed semi-clover leaf type without grade separate solution. This shape makes possible the future grade separation when traffic volume exceeds the capacity of at grade intersection.

Expected works at this specific location would be removal of existing roundabout, widening of the corner, new construction of road bed as well as a pavement, drainage reconstruction, traffic sign and signals installation, setting curbstone and marking. Detour and traffic management of the existing traffic during construction will be necessary.

Although the traffic count was not conducted around this intersection, Av. Julius Nyerere is one of the major roadways with a significant number of traffic, and will be part of the Maputo North-South BRT line. This intersection improvement would contribute to smooth flow of the traffic along Av. Julius Nyerere as well as A. Kenneth Kaunda.

Julius Nyerere/ Kenneth Kaunda Intersection: Possible Improvement

5) Joao Mateus

This intersection is T-shaped intersection of N2 which currently handles relatively a large volume of traffic to and from Matola City area. Current traffic from N2/N4 to and from Maputo counted about 16,000 vpd and 19,000 vpd respectively. Further development is expected along this street. The traffic from this development area will be a burden to this road and intersection leading to a bottleneck of N2/N4 highway unless appropriate treatment is made, such as a high capacity right turning lane(s), non-stop left turning lane and non-stop through lane. Traffic signal control will be effectively used for additional assurance of traffic flow.

The expected work will be focused on the intersection design and reshaping of the intersection, which is currently used uncontrolled manner. Channelization and road marking will designate the number of lanes and direction of traffic as well as signal control. Expected works at this location would be removal of existing markings, widening of the corner, channelization curbs, construction of road bed as well as a pavement, sidewalk construction, drainage reconstruction, traffic sign and signals installation, marking. Detour and traffic management of the existing traffic during construction will be necessary.

The major benefit of this intersection improvement would be smooth traffic and safety assurance of relatively large number of traffic between Matola and Maputo as well as through traffic along N2/N4 Highway thus contributing to a reduction in major congestion in Greater Maputo. The improvement will also contribute to the commercial and industrial development along this area.

Joao Mateus Intersection: Possible Improvement

(4) Provisional Cost Estimates

Provisional cost estimates for the construction of this improvement, though detailed investigation and design should be done in the later stage, are as follows:

	Item	Provisional Cost in USD
Facilities	1) Bananeiras Highway Access	2,000,000
	2) Rua do Jardim (Round about)	1,500,000
	3) Marginal intersection	2,000,000
	4) Julius Nyerere/Kenneth Kaunda	1,500,000
	5) Joao Mateus	2,000,000
	Sub-total	9,000,000
Design/Supervision		1,500,000
Grand total		10,500,000