Technical Report G

Traffic Control, Management and Safety

Contents

Figures

Tables

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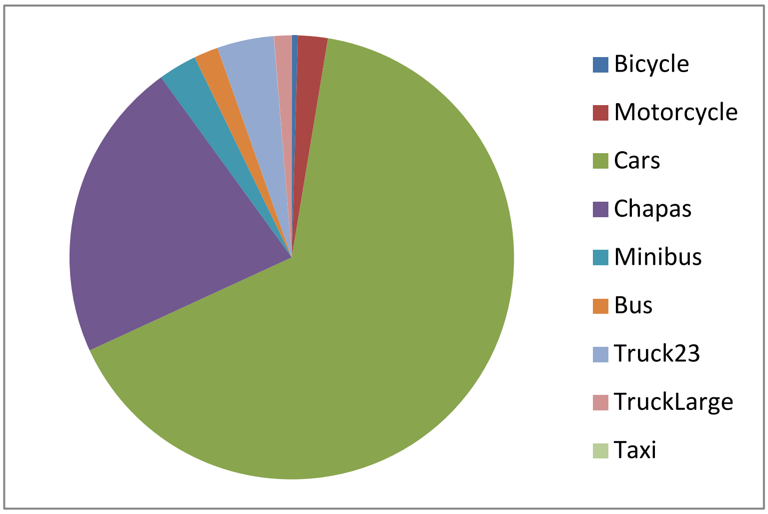
G.1 Introduction and Overview

This Technical Report presents the main challenges for traffic management envisaged during the study period. 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 considerations of land use/traffic interaction, safety and Traffic Demand Management (TDM).

The impression is often given that traffic levels in Maputo and on main roads are becoming saturated. In reality, although there are several bottlenecks, the overall traffic flows are not that high. The main problems are related to the loss of capacity due to encroachment, pedestrians forced into the highway by vendors and the irregular stopping of *chapas*.

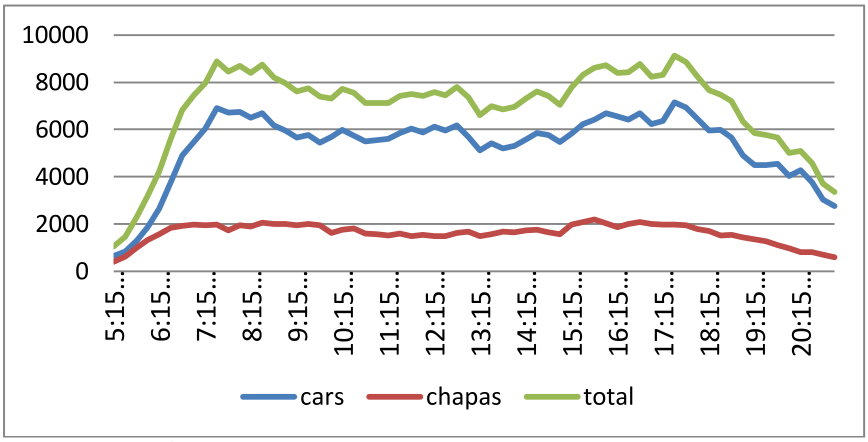
In terms of traffic composition, the sum of all junction counts carried out by this study as shown in Figure G.1 indicates that cars and *chapas* account for 88% of all vehicles (66% and 22% respectively). This percentage increases at junctions closer to the city center to over 90%.



Source: JICA Project Team

Figure G.1: Total Intersection Counts by Vehicle Type

When these total intersection counts over 15 min intervals are examined it can be seen in Figure G.2 below that the total *chapa* flows are close to one third of car traffic during the peak periods and remain almost constant throughout the day:



Source: JICA Project Team

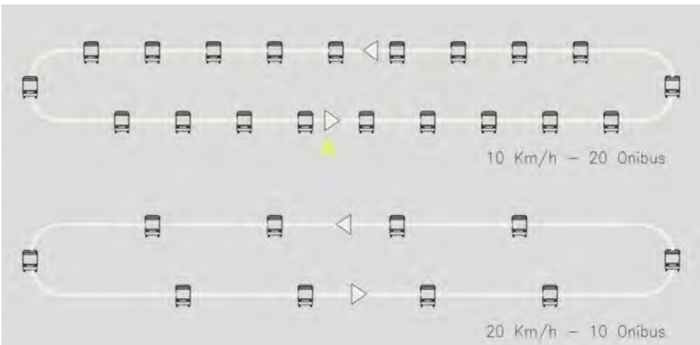
Figure G.2: Total Intersection Counts –
Vehicles Cars and *Chapas* by 15 min Intervals

There is little research into the passenger car unit values (pcu) of small informal transport vehicles, but a value of 2.5–3.0 has been put forward[1]. If a pcu value of 3 is used for *chapas*, it can be seen that they represent the same volume (in pcu's) as general car traffic.

However, this average value neglects the time period: during peak hours there are more passengers, stops and longer loading times/double or treble parking. It is worth noting that *chapa* flows are almost constant during the day, however, their impact is felt more in the peaks.

These counts also indicate that the overall peak hours are: 7:15–8:15 and 17:00 to 18:00. The evening hour is less concentrated with the period 15:45 to 16:45, all three periods having close to 8% of the 16 hour demand of total car and *chapa* traffic. Congestion problems tend to be more acute during the morning peak at specific locations, such as on the main access roads to the city.

Congestion is not just a question of wasted time, it also a major problem in terms of public transport capacity. In fact, a system that operates at 10 kmh will need twice the number of buses and drivers in order to transport the same number of passengers as a fleet operating at 20 kmh.



Source: NTU (National Union of Bus operators Brazil) – 2009

Figure G.3: Relationship between Bus Speed and System Capacity:
Fewer Fleet Units Required as Operating Speed Increases,
Resulting in Lower Operating Costs

[1] Informal Transport in the Developing World, Robert Cervero, United Nations Centre for Human Settlements (Habitat), Nairobi, 2000.

In the above Figure G.3, an observer at point ‘A’, for example, would see the same number of buses pass per hour in both situations. The difference is in the cost of running the system.

This cost in-turn, results in pressure on fares. A study by the Operating regulator of the Curitiba Bus System (URBS), for example, simulated the effects of lowered operating speeds:

Table G.1: Operating Speeds, Costs and Fares

	Present Value (Estimated)	25% Reduction	50% Reduction
Operating Speed kmh	20	15	10
Fare	USD 1.2	USD 1.39	USD 1.54

Source: URBS 2011

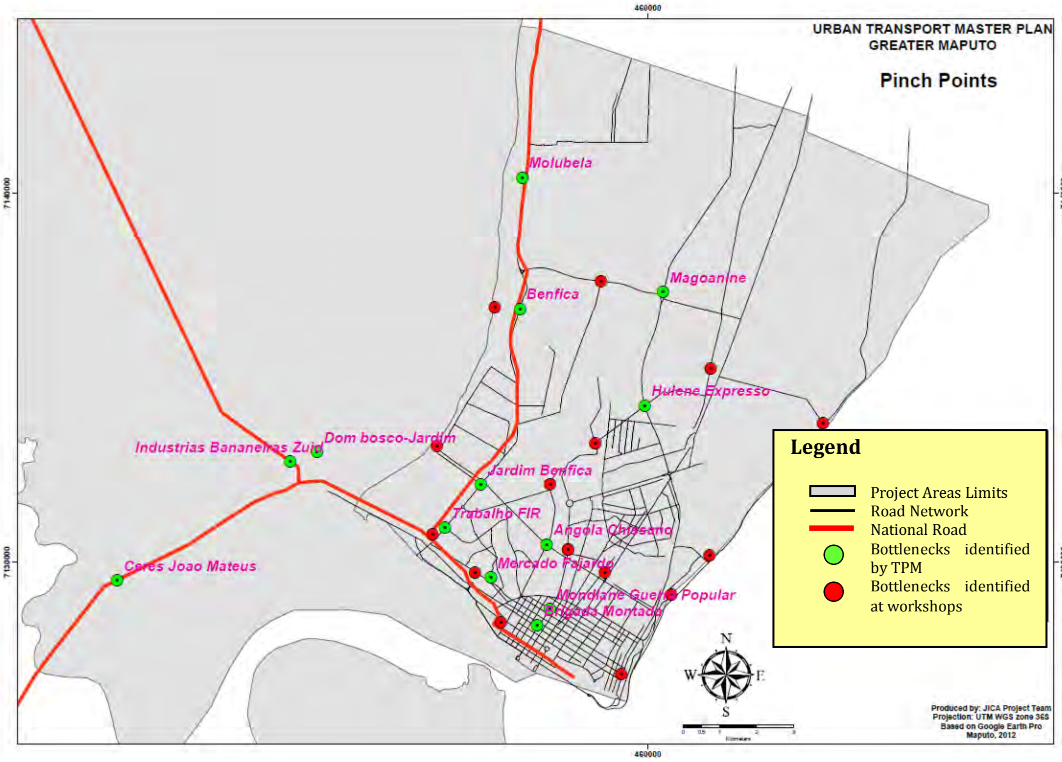
A 50% decrease in speeds results in a fare (cost) increase of 28% in order for the system to carry the same number of passengers.

G.2 Major Traffic Bottlenecks and Public Transport

G.2.1 Overview and Surveys

Bottlenecks are traffic congestion “hot-spots” where there is an excessive loss of capacity, time and public transport capacity. It should be borne in mind that a bus with a commercial speed of 30 kmh carries the same number of passengers as 2 units at 15 kmh, so that a drop in commercial speed signifies a corresponding drop in system capacity and/or rise in operating costs.

Observations were carried out on road network operation, including site observations and Working Group Sessions with TPM drivers (who were asked to define the worst zones or spots of “retention” during their work days). This invaluable experience from the main bus routes of the city, together with technical opinions from the second workshop and DMTT staff allowed for the preparation of Figure G.4, in which the TPM data is shown in green and the workshop opinions in red. These were then visited ‘in-situ’ in order to determine the causes of the problems and prepare short-term options of possible modifications, changes in layout and of urban structuring for discussion with DMTT counterparts.



Source: JICA Project Team

Figure G.4: Bottlenecks as Defined by the TPM Bus Drivers and Workshop Groups

G.3 Short-Term Interventions

Short-term traffic management measures fall into several basic categories:

a) Public transport priority and improvements;
b) Improved access to the new suburbs, the "Bairros Populares" along the main highways;
c) Road developments and urban structuring;
d) Junction improvements; and
e) 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.

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.

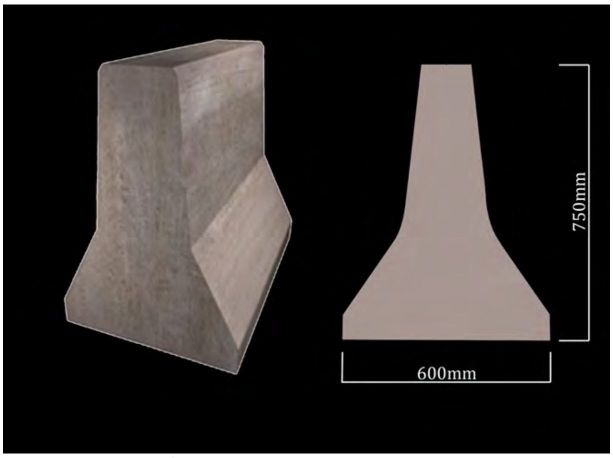
The concepts are shown as overlays on satellite images with the flows indicated and traffic signals represented by red circles superimposed over the flows.

G.3.1 Short Term Public Transport Priority and Improvement Package

(1) The N1

There is an urgent need to improve all public transport speeds on the N1 (Av. Moçambique). The main problems currently encountered are the haphazard loading of public transport vehicles at key areas and the encroachment of street vendors, pedestrians and passenger queues onto the roadway. This has led to a rise in pedestrian accidents (see section H5) and severe loss of capacity, which in turn drastically lowers peak period operating speeds.

The main problem zones at Benfica and Choupalhave have received a similar treatment as applied to the TRAC operated N4: pedestrian overpasses and concrete New-Jersey barriers of the type shown in Figure G.5 below, with embedded fences to minimize random pedestrian crossings. Even with these modifications, pedestrians, queues and triple parked *chapas* will still reduce traffic capacity and speeds.



Source: JICA Project Team

Figure G.5: Example of New Jersey Concrete Barrier

The option initially suggested by the DMTT was a new "reversible" public transport lane for express or direct services, using the division for passenger unloading at specified zones set at over 600m apart, building on the success of the existing reversible lanes. It was stressed that this lane could not handle loading, as units would form a queue of hundreds of metres and slow to near 0km/h. This lane would extend from the roundabout at Zimpeto to the viaduct at Brigada Montada and hence all direct services from Zimpeto – TPM and authorized *chapas* (based on, for example, the number of seats, etc.) – would be able to use the lane in full, with a minimum number of designated set-down areas. The services from Benfica would enter downstream from the loading zone and so on.

However, with the current issues around the informal nature of the public transport sector in Greater Maputo and with difficulties in enforcement, this option is not deemed to be workable.

The short-term traffic management recommendation for the N1 is the creation of "bolsões" or gyratory systems which minimize the retention at critical areas, as outlined in the specific section below. These not only provide better access to the residential districts, but would also help to reduce encroachment and, by creating one-way (two lane) crossings with no right conflicts, should increase capacity and provide an improvement in public transport speeds.

(2) Av. Angola

The DMTT plans to implement a 'reversible' 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 certainly simplify the causes one of the main bottlenecks, which are the right turn movements at these signals. The increased capacity in the southbound lanes, plus the extra capacity from the elimination of a right turn, will improve flows on both roads. The project also envisages the application of a South-North one-way in the evening peak, depending on demand.

However, this increased capacity will attract more traffic which will then 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. An on-site examination analysis of the traffic counts carried out by the DMTT indicates that the capacity of the existing system will not be sufficient to handle the full demand in the west-east directions. However, by adding a direct link and traffic signal as shown in Figure G.6, capacity will be increased. By also making Av. Manguigana one-way from this junction, some bus routes could be diverted from Av. Eduardo Mondlane, thus minimizing the congestion caused by the consequent right-turn at Guerra Popular (see Section H4 on signalized right turns), 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

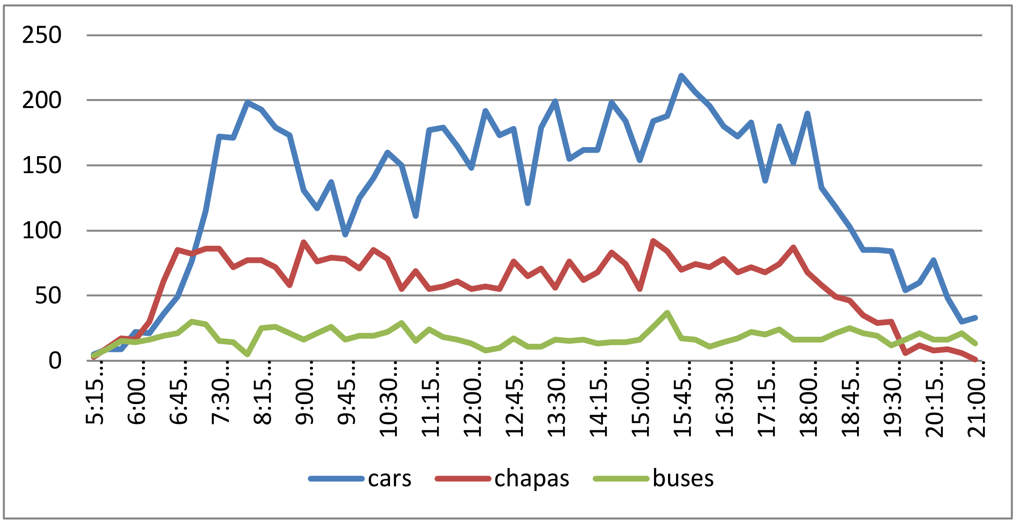
Figure G.6: Modification of the Av. Angola/ Marien Ngouabi Juntion

(3) 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.

According to the JICA Project Team traffic counts carried out at the junction of 25 de Setembro and Av. Guerra Popular, as shown in Figure G.7, the total number of cars on the stretch of Guerra Popular to the North in the evening peak is only about 350/h in each direction, traffic that could easily be carried by the parallel roads.



Source: JICA Project Team

Figure G.7: Two Way Car, *Chapa* and Bus Flows on Av. Guerra Popular

The proposed transit only section of Av. Guerra Popular is shown in Figure G.8. This would operate where the queues are greatest between Zedequias Manganhela and Av. Ho Chi Minh/Josina Machel. Police agents (shown in red) would stop the entry of general traffic through this zone. Access permits could be obtained – if needed – from the DMTT and parked vehicles would be allowed to be removed.

Source: JICA Project Team

Figure G.8: Proposed Transit Only Section of Av. Guerra Popular

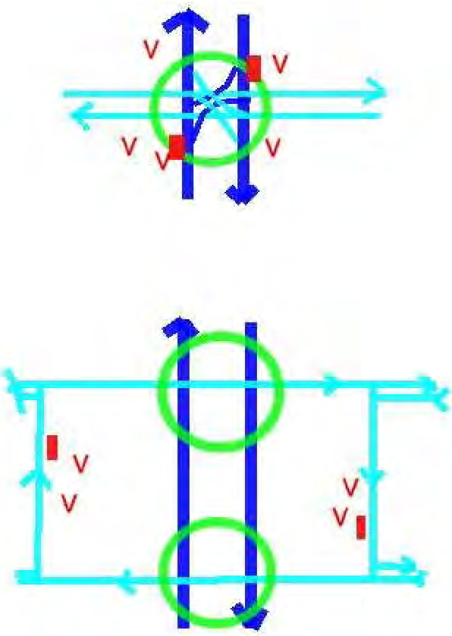
The actual volumes of general traffic affected are low, due to the level of congestion that discourages the passage of general traffic. Additional sample counts in November 2012 between Zedequias Manganhela and Av. Ho Chi Minh/Josina Machel indicated an evening peak flow of the order of 200 passenger car units in each direction (excluding *chapas* and buses), so few users would be affected and the impact on surrounding streets would be minimal. If accompanied by interventions in the prevention of encroachment of public space by street vendors and general street maintenance, then this measure would give a clear signal to transport users that giving preference to public transport is being taken seriously.

G.3.2 Improved Access to the New Suburbs, the "Bairros Populares" along the Main Highways

As mentioned above, access points to these districts are notorious congestion 'hot-spots' with large concentrations of turning movements, *chapa* terminals, street vendors and waiting passengers.

Adding extra road width only leads to further encroachment as enforcement of triple parking and informal markets is not currently viable.

A possible option would be to implement the concept known in Brazil as "bolsões", in which a new crossing with signals is added 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. The banned right turns would thus be made through a 'G' turn, as shown in Figure G.9.



Source: JICA Project Team

Figure G.9: Sketch of New ‘G turn’ Movements

This action attracts both informal transport and vendors away from the highway, leading to an enormous improvement in pedestrian safety – a major concern at 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.

(1) Benfica

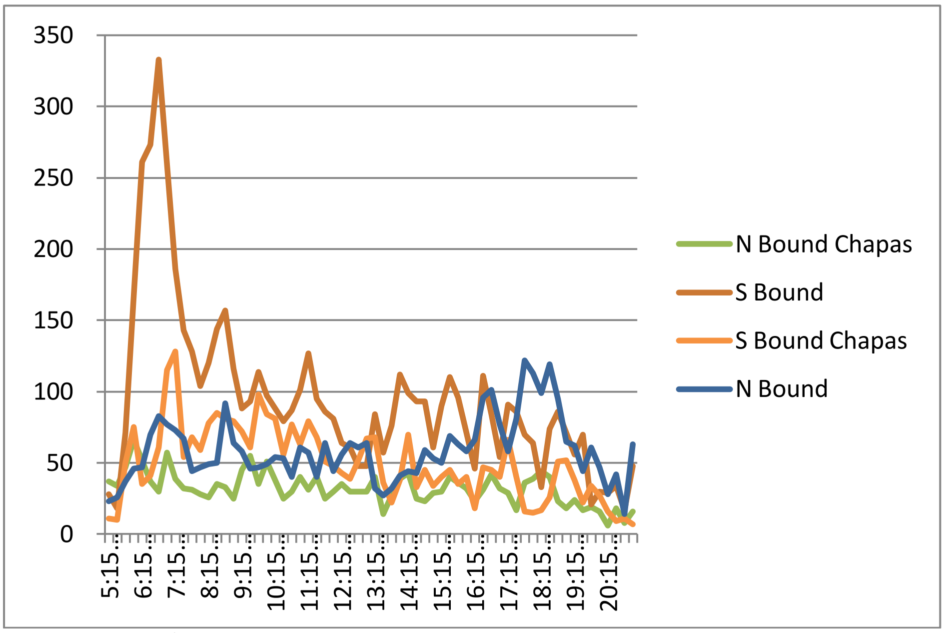
An example is shown in Figure G.10, which contemplates two crossing points for Benfica on the N1. The new roads to be opened or modified are the road on east side, and the link between the roads to the north, where limited resettlement takes place. This location was also found to be a pedestrian accident ‘hotspot’ (see the section on safety below) and the two crossings would also help to allow pedestrians and passengers to cross with less conflicting traffic flows.

Source: JICA Project Team

Figure G.10: Access to New Districts: Benfica "Bolsão"

The traffic signals would operate with only two vehicular phases, allowing for an increase in capacity and traffic signal plans adjusted to the actual demands.

Junction counts at the Zimpeto roundabout show that the traffic south of this junction has a pronounced morning southbound peak:



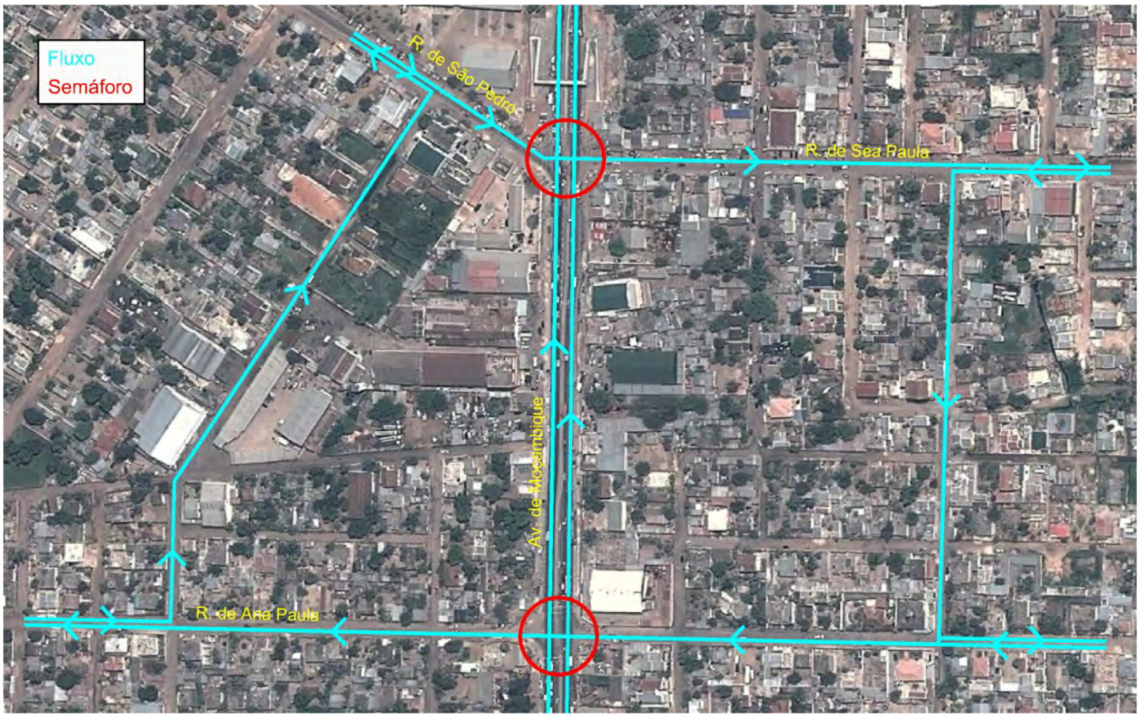
Source: JICA Project Team

Figure G.11: Traffic Volumes Benfica–Zimpeto

Importantly, the actual volumes (about 1000 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.

(2) Choupal "Bolsão"

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 as shown in Figure G.12.



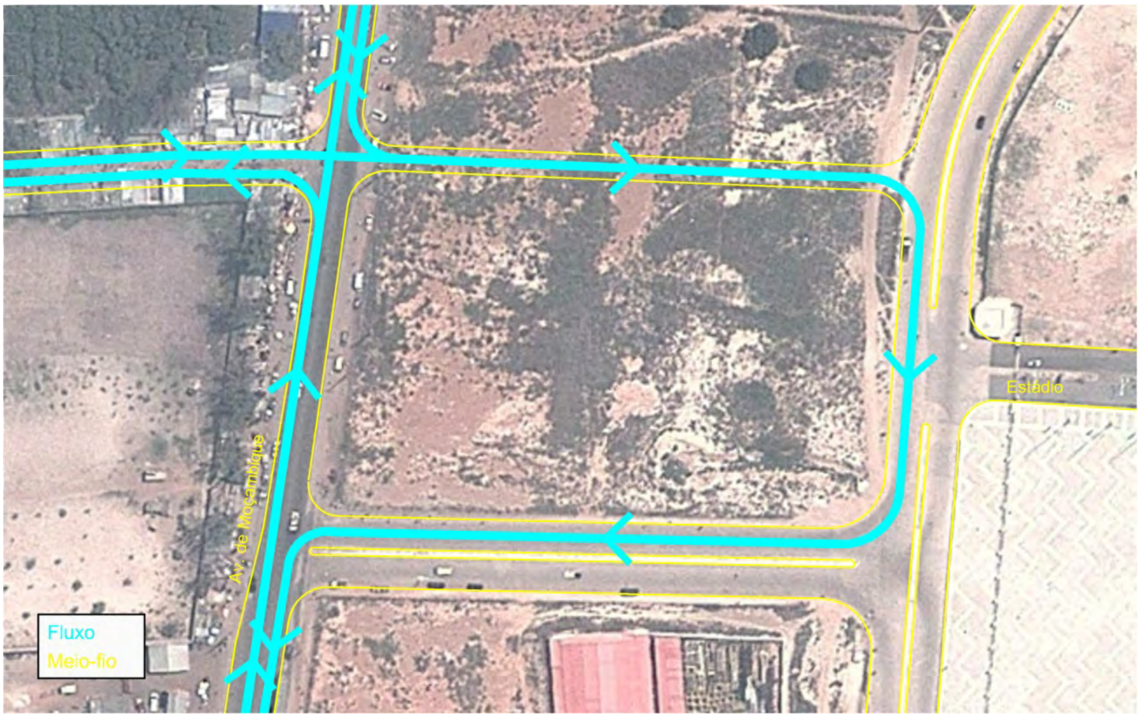
Source: JICA Project Team

Figure G.12: Access to New Districts: Choupal

(3) Zimpeto

The rapidly expanding districts of Zimpeto have both access and accident issues. The 'Mercado Grossista' zone, for example, was specifically quoted as a major pedestrian accident zone in the hospital survey (see Section H5). 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 allows traffic from the stadium two lanes to turn at all times onto the N1 (southbound) and at least one lane northbound.



Source: JICA Project Team

Figure G.13: Zimpeto Gyratory, Pedestrian Crossing, Stadium Access

G.3.3 Short Term Road Development and Urban Structuring Measures

(1) Av. Lenine

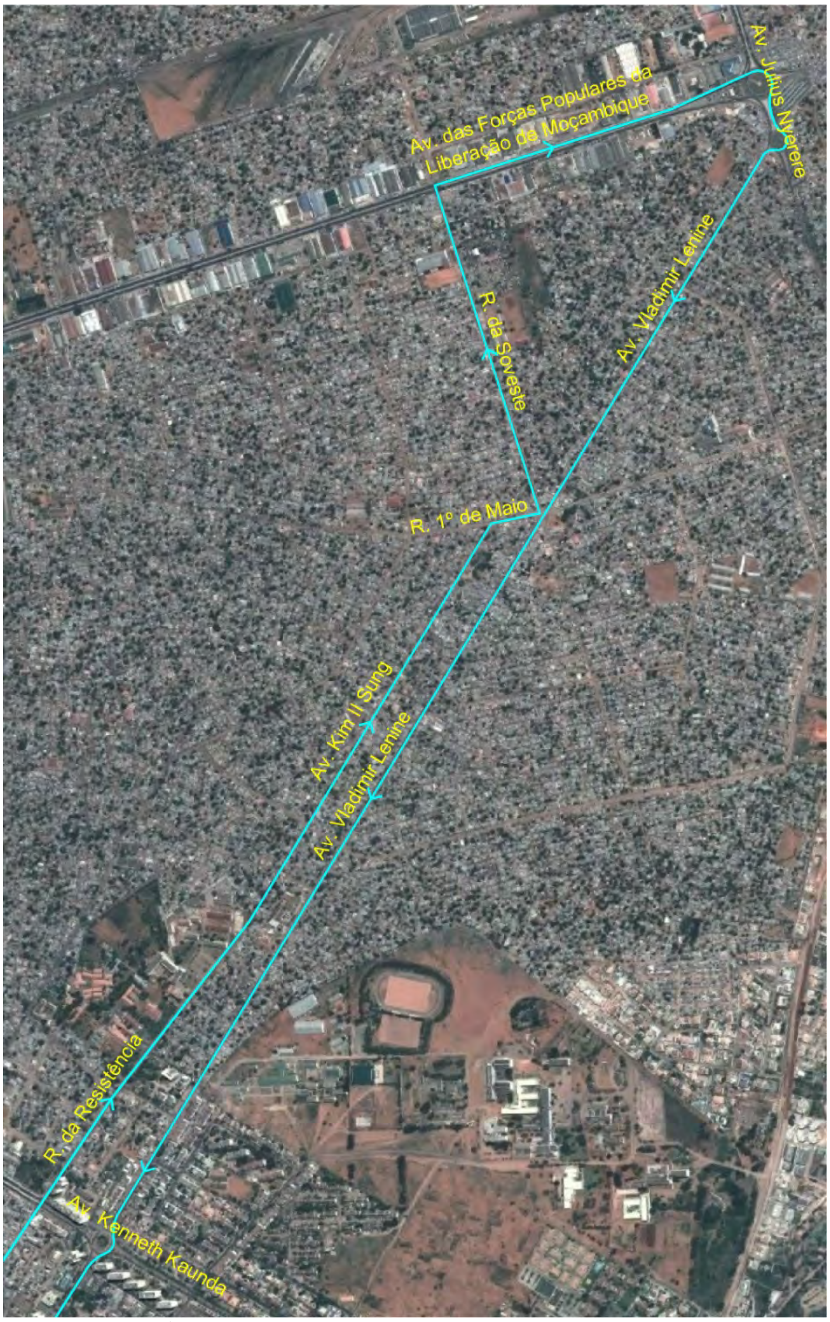
A simplified form of 'urban structuring'[2] for cities undergoing rapid or explosive growth and transformation can be utilized, based on the vectors of:

- Road Network;
- Public Transport Network;
- Land Use Planning; and
- Preservation of Green Areas.

Of these, the road network has the highest level of impact on the structure of the city, as accessibility is always the primary urban necessity. In many cases it is not viable to construct wide access roads through informally occupied areas or older residential zones, either in terms of cost or in environmental damage. As a result, the option of low-cost accessibility was encouraged, using one-way 'binary' road couplets. Thus an axis of development could be formed with 4 lanes by using two one-way streets of 8m in paved width.

An example of the use of this 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 (see Figure G.14). The latter is a wide, paved, but little used road that ends at the Escola Industrial.

[2] The School of Urban Planning, Curitiba, Brazil



Source: JICA Project Team

Figure G.14: Binary System: Lenine and Resistência

A 5 m dirt alley exists to the side that could be widened and paved without affecting any structure in the School, as shown in Figure G.15.

Source: JICA Project Team

Figure G.15: Opening the Resistência St. to Av Fredrich Engels

From Fredrich Engels there are two options: a short-term 'quick fix' through Engels and the once paved wide road of Av. Central to Primeiro de Maio (both would need to be repaved), the latter ideally one-way to minimize conflicts at the junction with Lenine. The "binary" would then follow the street Da Soweto, possibly as a peak period "reversível" (one-way during the peak –part of the local traffic culture) as shown in Figure G.16.

Source: JICA Project Team

Figure G.16: The Lenine/Av. Central Binary Section

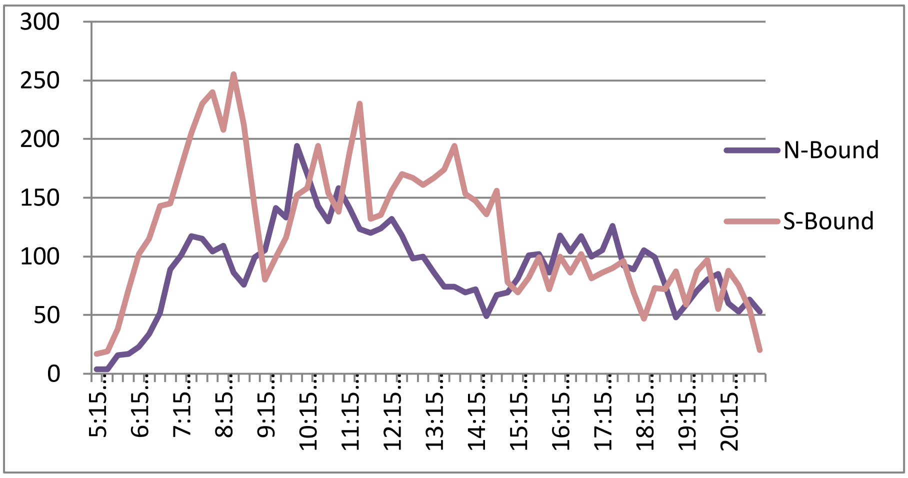
Lenine already operates as one-way (southbound) in the city centre, with only a stretch from the roundabout with Kenneth Kaunda to the church at Rua da Guarda with two-way traffic. This could remain in operation, although with a binary system, northbound traffic would be greatly reduced.

Source: JICA Project Team

Figure G.17: New Signal at Resistência St and Joachim Chissano

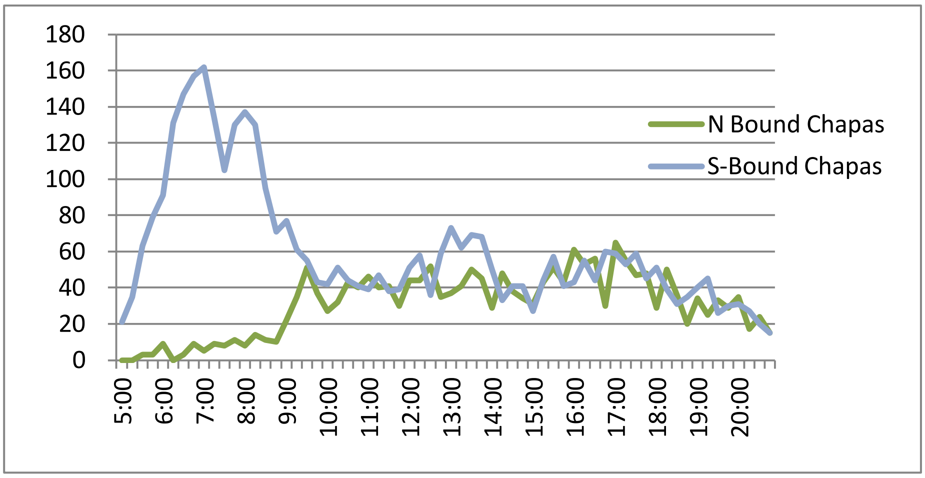
The morning peak 'reversible' operation is especially critical when the peak flows are examined. Figure G.18 and Figure G.19 show the current car and *chapa* traffic flows per 15 minute interval on Av. Lenine to the north of the junction with Joachim Chissano, based on the project team counts.

The morning peak flows of some 800 cars and 600 *chapas* per hour (a total of some 2,600 pcus/h) are clearly too high for the single-lane road with signals. Operating on a one-way basis, however, this major transport corridor would allow for a significant increase in traffic and transport capacity.



Source: JICA Project Team

Figure G.18: Car Traffic Flows on Av. Lenine North of Joachim Chissano

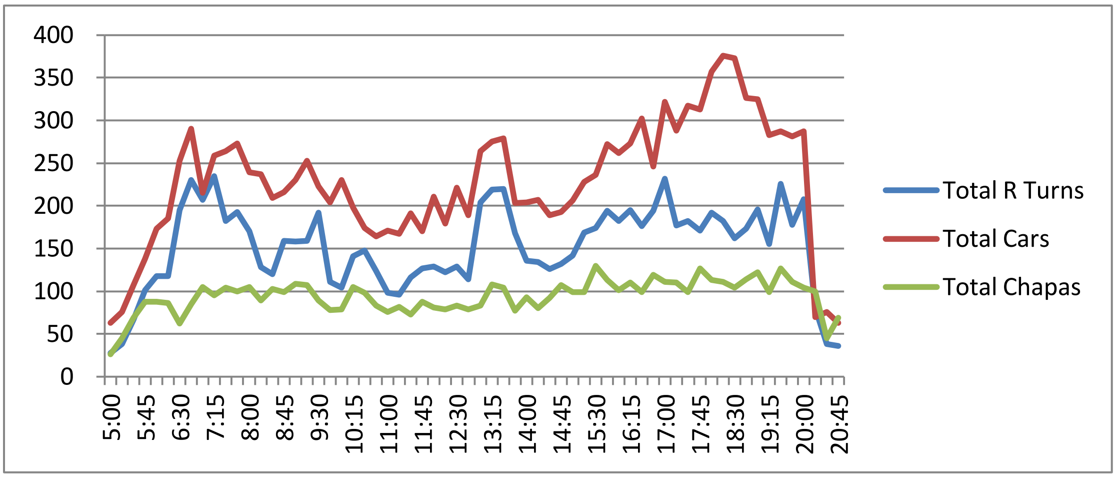


Source: JICA Project Team

Figure G.19: *Chapa* Traffic Flows on Av. Lenine North of Joachim Chissano

(2) 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, and it is possible to add an extra approximation lane to minimize the problem with right turning (South to East) traffic. However, the problem in terms of overall structure is that the entire zones on both sides of the highway have to rely exclusively on this one access to and from the highway.



Source: JICA Project Team

Figure G.20: Rua da Beira x Julius Nyerere: Total and Right Turn Flows

This leads to an excess of right turns at the junction as can be seen in Figure G.20; although the total flow would not usually be considered heavy, the large number of right-turns (plus the usual encroachment, vendors and queues) imposes large delays at the junction for through movements. The turning flows onto Rua da Beira then suffer from the congestion along this only paved road.

A solution of the 'bolsão' type would require large scale resettlement as no existing road system is available. To counter this, 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 does not integrate with the highway network.

To fully reap the potential benefits of this paving, a better quality link is needed to the main road. This can be achieved by using the RoW of the railway and by opening a short stretch of informal settlement next to the football ground. Note that the RoW would not be built-up, simply have a modified surface from the present stones and dirt to paving. This new road would exit at a signalized junction next to the rail overpass (Figure G.21). The space available is sufficient for the addition of a left turn lane (NE-S) to avoid delays and an additional lane for right turns (S-NE).

Again, this is a technique that is widely used in Brazil for short-term and low-cost access, the concept of using RoW 'non-edificandi'– or land which may not be built-up – for paving being widely established.

Source: JICA Project Team

Figure G.21: The Rail RoW Link to Cardeal Alexandre dos Santos

G.3.4 Short-Term Junction Improvements

(1) Matola Sede/CERES

The signalized junctions on the N2 were quoted several times in the driver's survey as major bottlenecks. These signals are installed and operated by TRAC, which also the junction designs (as approved by INAV). Matola does not have as yet the technical expertise to install, maintain or program signals and signal timings are not a part of the TRAC brief.

The right turn from N2 to N4 is particularly heavy and conflicting; two lanes have been provided and operate as an 'early cut off', in which a short green time is allocated to the turn and through traffic. From the junction traffic counts the morning peak hour values are shown in Table G.2 below. This also shows the blocks of conflicting flows (colour coded) and their respective saturation flows and 'y' values (flow/Sat. Flow) based on international practice.

Table G.2: Junction N2/N4: Conflicting Flows, Saturation and Green Times

Morning Peak h	Mov 1	Mov 2	Mov 3	Mov 4	Mov 5	Mov 6	Mov 7	Mov 8	Mov 9	Mov 10	Mov 11	Mov 12	Sum Y
Total Entry Flow	311	480	354	490	287	197	241	141	24	828	170	434	
Sat. Flow		3600		3000						3600			
		1 145								997			
y		0,318		0,163	0					0,277			**0,758**
% green		42%		22%						37%			

Source: JICA Project Team

Thus, applying Webster' formula (Table G.3) for the calculation of optimum cycle length for traffic signals, and taking as 'lost time' the sum of both amber phases plus a 2 second 'clearance' time, this gives a cycle of 85s. with the green times shown below:

Table G.3: Junction N2/N4: Webster's Formula

Value	Mov.2	Mov.4	Mov.10	Sum
Y	0.32	0.16	0.28	0.76
% green	42%	22%	37%	
C = 85 optimum green	32	16	27	75s
C = 50 actual green	20	5	15	40s

Source: JICA Project Team

It should be stressed that this calculation does not include pedestrian crossing times – which are presently non-existent and should be introduced. In fact, the cycle time is 50s and with the green times shown. These timings are constant throughout the day, showing the room for improvement just by optimizing the timings within the capacity of the on-site equipment (fully capable of at least 4 programs).

The same situation can be seen at the access to Matola Port; the cycle time is again 50s and with peak green times un-optimized and under police control.

The signals at the junction João Mateus have now been disconnected, forcing all conflicting flows to enter and exit as best they can – a situation that is highly dangerous for all users - including pedestrians.

(2) 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 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.

Source: JICA Project Team

Figure G.22: Bananeiras Highway Access Problems

The DMTT is already discussing with TRAC the improvement of the entry ramp and a further solution to these issues is to correct the geometry of the roundabout and leave a minimum weaving space as shown in Figure G.23 below.

Source: JICA Project Team

Figure G.23: Bananeiras Highway Access: Possible Solution

Downstream, the retention mentioned is largely caused by a signal (which has been non-operational for most of 2012). There is enough space at this junction to operate this as a roundabout with a diameter of some 22 m. In countries such as France and Brazil that have traffic cultures used to smaller gap acceptance times, roundabouts have proved to offer higher capacity levels, specifically when signals require three or more traffic stages.

Source: JICA Project Team

Figure G.24: Av. Indústrias Access at Rua do Jardim: Solution with Roundabout

As well as distributing all flows according to demand, the use of a 5m wide 'apron' of low stone pavement would allow for extra-large goods vehicles to pass.

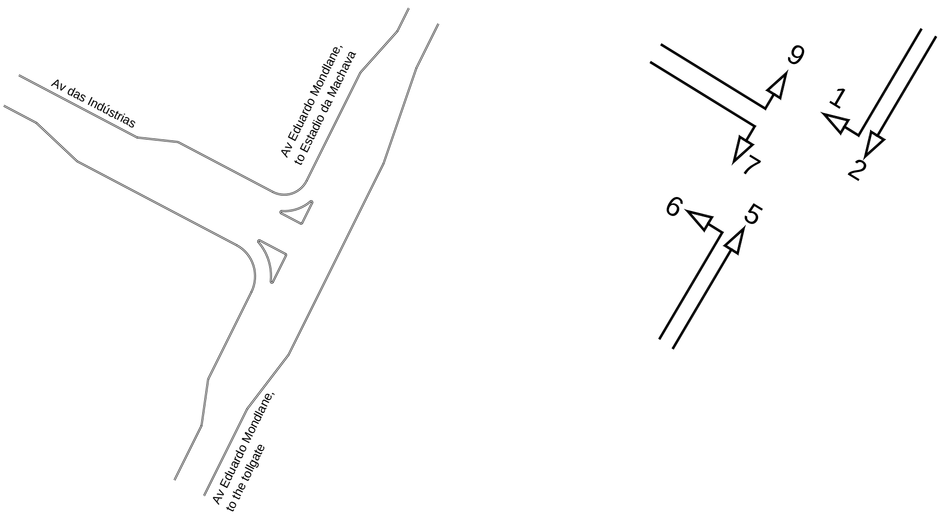
Source: Oregon Department of Transportation 1998

Figure G.25: 'Apron' on Roundabout to Handle Large Goods Vehicles

The peak hour at this junction is actually closer to 11:00 to 12:00 due to heavy goods movements. These peak hour flows by vehicle type are shown in Table G.4 below. This table shows that most of the larger vehicles use this junction for N-S and S-N through movements and that the total number of approach flows is well within the capacity of a roundabout of these dimensions.

Table G.4: Peak Hour Flows and Composition at the Av. Industrias/Eduardo Mondlane Junction

	Mov1	Mov2	Mov5	Mov6	Mov7	Mov9
Trucks	13	93	50	21	3	11
LargeTrucks	11	73	37	17	3	9
Chapas	102	96	49	13	13	197
Cars	99	221	220	166	236	93



Source: JICA Project Team

A similar situation exists at the access to Machava with Rua do Jardim, where a signalized junction has problems with signal timings which are set at a cycle of 120s. The main problem, however, is the North-West traffic island, which appears to have been mis-located leaving a very narrow (about 6.5 m) two way approach yet a 9 m side road for turning flows.

The suggestion is to relocate the island, leaving a 10m two-way approach that can handle the high volumes of very large trucks trying to turn – forcing the approach queue to back-up – and allowing a 6m turning lane as used at junctions on the N2.

This is shown in Figure G.26 below:

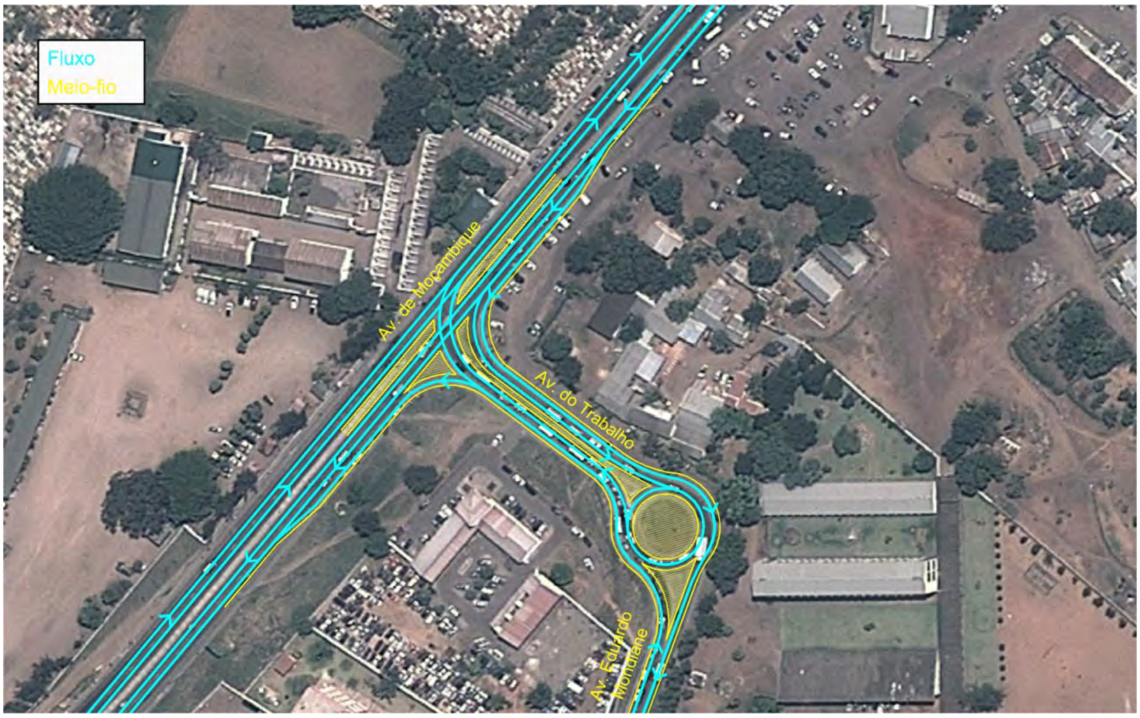
Source: JICA Project Team

Figure G.26: Machava Rua do Jardim Access

(3) 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 – as can be seen in Figure G.27 below. Two short-term measures would alleviate this problem:

- Improved signal timings and better use of the traffic plans available within the equipment (see section H 4.3)
- Addition of extra lanes on the link between the highway and the roundabout.



Source: JICA Project Team

Figure G.27: Av. Moçambique/Av. do Trabalho /FIR

G.3.5 Linking New Projects with the Existing Road Network

Several major roadworks 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 has also been recommended.

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. To increase capacity the junction needs to be redesigned as part of the final design with all the major flows (SW-N, N-SW) operating with two lanes. To avoid a three stage traffic signal, it is recommended that the movement SW-NW 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 has sufficient capacity to handle traffic demands; 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 G.28.

Source: JICA Project Team

Figure G.28: Av. Marginal, Access to Av. Julius Nyerere and Kenneth Kaunda Junction

Therefore the junction would then operate with two main stages: Julius Nyerere and the transit way green) and the Marginal and Kenneth Kaunda flows. There is no right turn from North-East to North as this movement will be small and can be made at the junction 1,400 m to the north. The right turn (S-NE) would be banned as this can be made through a “P” movement (i.e. making three left turns) and using Kenneth Kaunda.

G.4 Traffic Signals

G.4.1 Overview

Signals were mentioned several times as major bottlenecks during the driver interview surveys and at the second workshop. This is largely due to the following factors:

- Signals are at junctions that tend to concentrate *chapa* stops, and these stops in turn create queues that attract street vendors as well as pedestrian crossing flows. As the *chapas* 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 blocking of approaches.
- In the central area the signals operate (with few exceptions) without synchronization, causing long queues and waiting times.

On the positive side, signals (during daylight hours):

- Are reasonably well respected by all users during the daytime.
- Offer safer opportunities for pedestrians to cross busy streets.
- Green times are not interfered with by traffic police.
- Signal controllers have at least 4 traffic plans in operation (although the timings are not always based on real traffic data or demands).

Pedestrian signals, however, such as on Av. Lenine (near the church) are not shown the same respect as drivers know that there is no risk of collision with other vehicles. Pedestrian timings at junctions are also a risk as some drivers simply ignore the all-red times and proceed.

The Control Centre (CCO) planned for all traffic operation is built and this section assumes that in the short-term there will be an upgrading of all signals to include supervision and some form of real-time operation.

G.4.2 Warrants for Signals

When two or more traffic flows are competing for the same road space at a junction, some form of control or set of rules is needed to minimize delays and the risk of serious accidents. With higher flows some form of **stop or priority** sign is used to inform to the user on one or more approaches that the other road has right of way. At even higher flows this form of control breaks down when the delay on the minor road becomes too high, forming queues and forcing drivers to run the risk of accepting gaps in the major road traffic that are too small for a safe crossing. At this point, time must be allocated for the right-of-way to traffic on the various approaches.

However, the introduction of traffic signals (or lights) into a city often runs the risk of this equipment being considered a panacea for all traffic problems. The engineer in charge of the traffic can come under political and popular pressure to install too many signals, thus leading to the even greater risks of red-running – as the users 'learn' to disrespect the red lights that they consider to be unnecessary.

To avoid this problem it is essential that the engineer or traffic department has 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 signalled route; and
f) where there is a record of accidents of the type which 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 1500 pcu's 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.

G.4.3 Signal Timings

Most controllers in operation have the capacity to operate 4 or 24 traffic plans or sets of timings. This allows for optimum cycle times to be chosen and green times to vary according to the peak and off-peak demands.

Traffic signal coordination is one of the most important aspects of good traffic signal operation on arterials. Signal coordination ensures that motorists are able to travel through multiple intersections at a prescribed speed without stopping or with an absolute minimum of stops and fuel consumption.

Regardless of whether an individual signalized intersection is coordinated with other nearby signals or operates totally independently, there are issues that are critical to how well that intersection operates and serves the public. Reviewing and updating the intersection-specific timing and operational aspects of individual signalized intersections on a regular basis is extremely important, especially where changes in traffic volumes and/or adjacent land uses have occurred since the last review. The issues include reviewing and updating the phasing sequence, detectors, displays, timing parameters and other related operational aspects of individual signalized intersections within a jurisdiction.

According to the Traffic Signal Operations and Maintenance Staffing Guidelines, March 2009, of the US Federal Highway Administration, timing design practices should include the following:

a) Review of intersection performance data every three years to determine whether geometric improvements can remedy approaches exceeding 90% saturation for 200 hours per year on weekdays and 100 hours per year at other times.
b) Review of intersection performance data for phasing and type of signal control.
c) Review of signal timing performance using a documented methodology should be performed at periods established by management plans but should not exceed 30 to 36 month periods to identify the need for retiming. Where automatically collected data is available, it should be reviewed at 6 month intervals to determine the need for more rapid retiming.
d) Retiming of signals should be performed as part of this review cycle. Data should be collected as necessary to support the retiming process. Timing plan updates should be performed using an accepted methodology such as SYNCHRO, TRANSYT 7F, etc.
e) Retiming should be completed and checked in the field within 3 months of identifying the need for retiming.
f) A methodology for determining the number of daily timing plans required as well as weekend and special function timing plans should be utilized. Factors such as saturated approaches, spillback from intersections and turning bays should be given.

Green times are rarely optimized, largely due to the time and cost of obtaining data. In emerging economies the cost of carrying out counts can be prohibitive.

A more cost-efficient manner is to collect data by sampling. During a peak hour, for example, counts (volume and composition) can be obtained for two ten minute intervals of, typically, exiting flows (where a single surveyor can handle two conflicting flows).

The table below shows how confidence varies for different sized population universes. For flows of some 1800/h, a ten minute interval will sample a sufficient number to give a 95% degree of certainty (+/− 5%). Two such intervals will increase this level of certainly. If the minor road has a flow of about 600 vehicles, the degree of certainty in ten minutes is less (+/− 8%). As low flows tend to operate on minimum green times that are set for safety and pedestrian needs and as saturation only occurs at higher flows, a lower degree of certainly is less of a problem for lower flows making this method ideal for signal timing.

Table G.5: Confidence in Sample Sizes for Different Universes

Universe/ Population	Confidence Level	Confidence Interval	Sample Size	Volume in 10 minutes
300	95	5	169	50
600	95	5	234	100
1,200	95	5	291	200
1,800	95	5	317	300
2,400	95	5	331	400
3,000	95	5	341	500
Universe/ Population	**Confidence Level**	**Confidence Interval**	**Sample Size**	**Volume in 10 minutes**
300	95	8	100	50
600	95	8	120	100
1,200	95	8	133	200
1,800	95	8	139	300
2,400	95	8	141	400
3,000	95	8	143	500
Universe/ Population	**Confidence Level**	**Confidence Interval**	**Sample Size**	**Volume in 10 minutes**
300	95	10	73	50
600	95	10	83	100
1,200	95	10	89	200
1,800	95	10	91	300
2,400	95	10	92	400
3,000	95	10	93	500

Source: http://www.surveysystem.com/sscalc.htm

The data collected – transformed into pcu's – can then be used as inputs for the estimation of the optimum signal length and the calculation of green times.

G.4.4 The Operational Control Centre (CCO)

The Operational Control Centre (CCO) is part of the ProMaputo II Programme. 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). Most signal heads now have LEDs which have drastically reduced maintenance costs and theft of light bulbs. By 2013 the DMTT expects that all signals will operate with LEDs.

G.4.5 Conflicting Right Turns

There is no doubt that the continued allowance of right-turns in Maputo city centre will no longer be viable in the short to medium term, as traffic volumes increase. The loss of capacity due to the need for a queuing lane, the loss of green times and the conflicts with pedestrian flows all lead to the conclusion, universally adopted in big cities world-wide, that these movements will have to be banned and replaced by the aforementioned "P" or "G" movements that one-way systems permit. As mentioned above, 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.

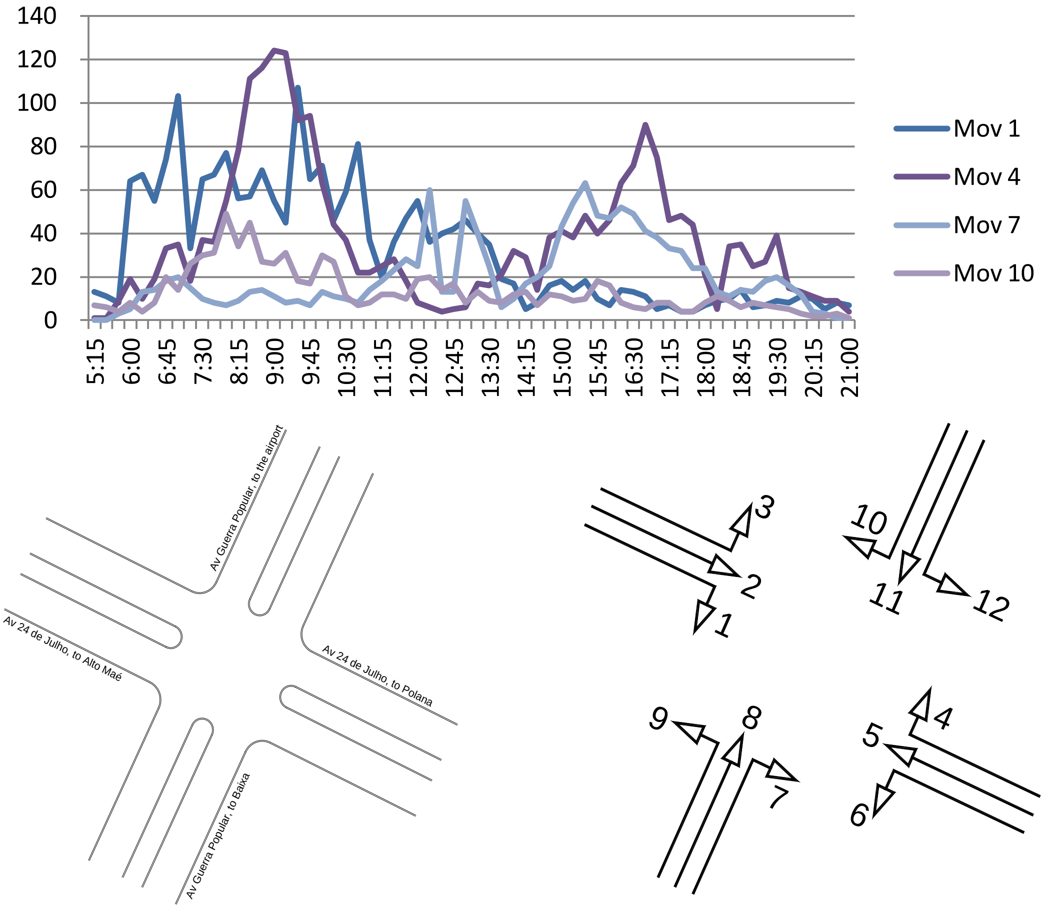
This will be an issue during the installation of the Area Traffic Control System as the presumed benefits from the signal upgrade will not be fully realized if most right-turns are left as they are.

Essentially, the same concept as the "bolsões" on major highways has to be incorporated into the local traffic culture; in which right-turns are banned and a reasonable option is signaled before or after the turning.

(1) Examples: Priority for Guerra Popular

The junctions of Avenidas Guerra Popular/Eduardo Mondlane/24 de Julho are shown as worked examples. At 24 de Julho the right turning flows of *chapas* (shown in Figure G.29 below) indicates that movement 1 (Mov1) is highest between 6 and 9:30 am, when an alternative for *chapas* is already available in the form of the liberated right turn on the existing 'reversible' one-way section of 24 de Julho and Alberto Luthuil.

The other major movement is from Museu to the North (Mov 4) at the peak hours of 9:00 and 17:00. This can be handled via a making the section of Ho Chi Minh one-way westbound and opening the median on Guerra Popular at the junction.



Source: JICA Project Team

Figure G.29: Right Turns Flows of *Chapas* at the Junction of Guerra Popular and 24 de Julho

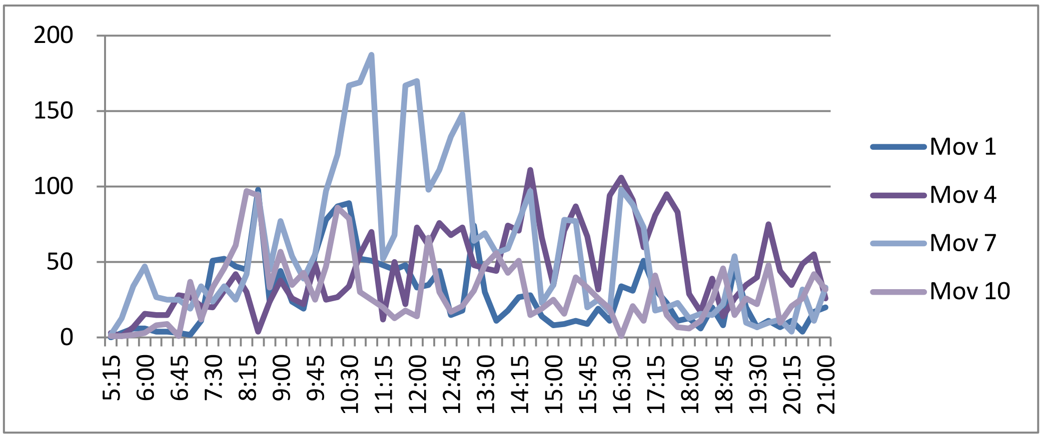
As can be seen in Figure G.30, the substitution of these right turns will need the addition of three new light controlled junctions, which are indicated by red circles. The timing and coordination of these would thus be necessary as part of the Area Traffic Control system. In the morning peak, if Av. 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.

Source: JICA Project Team

Figure G.30: Elimination of Right Turns along Av. Guerra Popular

(2) Avenidas Karl Mark and Eduardo Mondlane

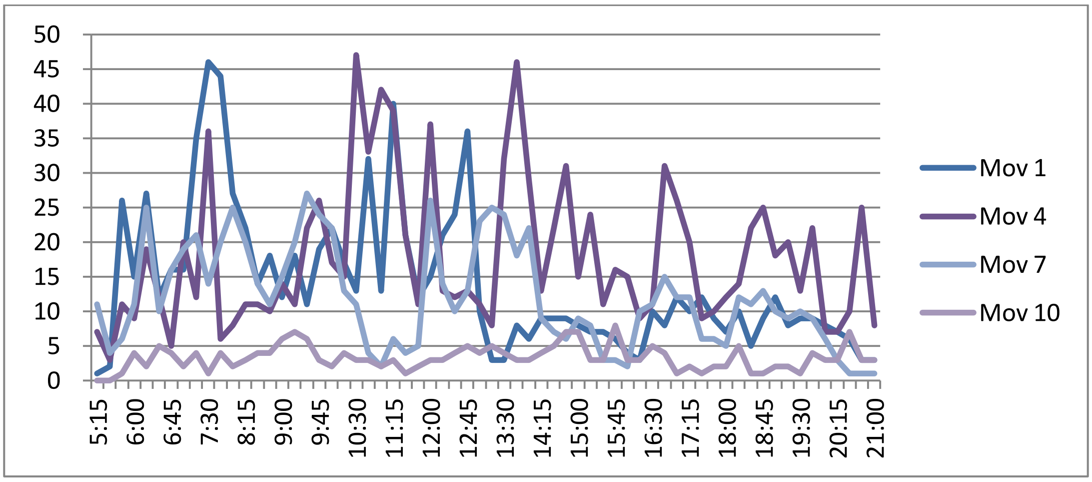
A similar situation exists at this junction where right turning cars and *chapas* account for 27% and 35% respectively of total daily traffic. Prohibited right turns for cars can easily be handled via the modified road system, with the possible exception of the turn S-E, which presents a lunch-time peak as seen below in Figure G.31 (Mov 7, same key as in Figure G.29 above). However, this traffic could be diverted to Felipe Magaia.



Source: JICA Project Team

Figure G.31: Car Right Turning Movements per 15 Minute Interval: Avenidas Karl Marx and Eduardo Mondlane

The *chapa* flows are relatively low and fairly constant throughout the day. The routes making these turns should be diverted to other road links.



Source: JICA Project Team

Figure G.32: *Chapa* Right Turning Movements per 15 Minute Interval: Avenidas Karl Marx and Eduardo Mondlane

G.4.6 Adaptive Signal Control (ASC) and the Operational Control Centre (CCO)

Centralized Signal Control has changed dramatically over the past decades as faster, cheaper and more powerful IT and communication technology has been adopted. Modern systems tend to use GSM cell phone technology for local controllers, collecting data at a "master" and with a land line wire connection from this to the CCO (or using full GSM). Internet access to the units allows for a notebook control (rather than handheld devices) and traffic plans and data are stored in the controllers and passed down through the system in pre-processed 'packets'. Loop detectors in the asphalt have been replaced by video and CCTV by internet video links. The mainframe is now a standard desktop and LED TV screens have replaced projected images. Even congestion data is available in many countries directly from Googlemaps (based on real-time GPS data from the car fleet).

In theory, sophisticated software should allow timings to be optimized in real-time. In practice, most software are slow to detect and correct problems and have difficulty in adapting to situations of bus priority and emergency services. In developing cities the problems of accidents, irregular bus stops, encroachment and road repair etc, erode efficiency.

Again, the geometry of the road network – especially in 'grid' type networks – determines that signal settings and synchronization result in a specific plan that, for the same cycle, changes little with flows. Changes in cycles result in a loss of capacity and higher user risk (when a usual sequence is modified). Most traffic software in use has thus changed little since the 90's despite the rapid advance in computing power. Some changes have occurred including:

- The perception that Area Traffic Control is less about optimizing throughput and more about managing overall congestion and emission levels.
- The introduction of simpler and more cost-effective Adaptive Signal Control (ASC) technology to adjust the timings of red and green lights to accommodate changing traffic patterns and ease traffic congestion.

- User technology aimed at optimizing the individual's path to minimize delays. In other words the computing power and GPS have gone to the level of individual units rather than to the system.

Poor traffic signal timing contributes to traffic congestion and delay. Conventional signal systems use pre–programmed, daily signal timing schedules. ASC signal control technology adjusts the timing of red, yellow and green lights to accommodate changing traffic patterns and ease traffic congestion.

The main benefits of ASC technology over conventional signal systems are that it can:

- 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; and
- Prolong the effectiveness of traffic signal timing.

The Maputo Traffic Control System will probably have minimum of data collection and thus will depend on the use of pre-planned timings calculated off-line (even if the calculations are done on the system computers). These will also have to take into account the large pedestrian flows and public transport movements (both *chapa* 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. If this is not readily available, the PRAXIS simulation package can be obtained, in Portuguese, from the site: http://www.sinaldetransito.com.br/praxis/vestibulo/entrada.php

(1) Area Traffic Signal Control System

The proposed short/medium term traffic signal control system is envisaged as an ASC type system, initially using traffic plans optimized on a 24h/ 365 day basis.

The Control System for Adaptive Real-Time Traffic encompasses a set hardware/software which 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 centralized control system must be operated in a hierarchical way, structured in three levels:

- Local controllers are the first level.
- The second level consists of wireless communication modules like GSM / GPRS of hard wire network. The system should also accept equipment type coordinators, master controllers or central area "server equipments".
- The third level is made up of central control, communication modules connected to GSM / GPRS or "server equipment" or sub-area master controllers.

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 modules GSM/GPRS installed in the field, has the primary responsibility for transmitting information.
- The Control Center will have the following main responsibilities:
  - Monitor the traffic situation;
  - Monitor the status of the equipment; and
  - 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.

If the latter fails to receive commands from the control center, these will directly command the lights, using basic traffic plans previously optimized off-line. All security parameters should be preserved without creating unsafe conditions for motorists and/or pedestrians.

The Control Center should foresee a minimum capacity of a three hundred (300) controllers that may be linked to the system.

The system should have the capacity to incorporate the following ASC features as needs be:

a) Perform Real-Time Dynamic Plan Selection Adaptive Control.
b) Detect and record all failures in the operation of detectors, controllers, equipment, servers and network data communication.
c) Continuous collection and statistical processing and storage of traffic data collected from vehicle detectors, such as vehicle counts and occupancy calculations.
d) Transmission and storage of basic local traffic plans, from the Control Center, the controllers.
e) Alarm messages to the Control Center, in the cases of:
   - Equipment failures;
   - Communication failures;
   - Controller open door location;
   - Light malfunction, indicating the color and corresponding signal group;
   - Controller flashing (on alert); and
   - Conflicting green signals.
f) If provided with a detection system for vehicles:
   - Provide data compatible with the operation of the control system in real time;
   - Generate statistics of flow and occupancy;
   - Generate alarms congestion;
   - Performance when necessary; and
   - Facilitate the installation of electronic surveillance of obedience to the red light.

(2) BRT Priority

The 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 without modifying the architecture of the equipment offered, in order to increase the priority given to these vehicles.

The systems that are generally offered for BRT priority include:

a) The use of BUSTRANSYT 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.
b) The use of TAGs on the BRT units that 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. In both cases the area wide cycle time remains the same and overall congestion levels are considered as part of the priority algorithm.

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.

(3) Operator/System Interface

The operator should be able to act on the central computer control to perform at least the following activities:

a) Change and enforce basic traffic plans on a controller individually, in a group or by sub-area.
b) Create a plan not provided and store it in a controller, in a group or for an entire sub-area.
c) Obtain reports on the operational status of the system at the sub-area level on failures, and modes of operation.
d) Read, modify and send basic traffic plans to traffic controllers.
e) Change the configuration of the subareas, placing one or more controllers in a new subarea.

The system must be able to display on the operator's screen the conditions of the entire area under control, so as to enable successive operations of "zoom":

a) Area of Control, showing:
   - Main roads in simplified form;
   - Name of the streets;
   - All subareas; and
   - All intersections controlled.

b) Intersections:
   - Name of the streets;
   - Traffic direction;
   - Signaling;
   - Location of any vehicle detectors;
   - Location of the lights;
   - Identification of the light groupings;
   - Location of the controller;
   - Diagram of the stages at the intersection;
   - Mode of operation;
   - Plan in use;
   - Parameters of the existing plan;
   - The colors of the groups in real time;
   - Failures of the controller; and
   - Traffic flow and occupancy at the time (if detectors are installed at the intersection).

(4) Medium Term Expansion

In developed countries the number of traffic signals tends to be a function of the population size, however, in rapidly developing economies this is not the case as car ownership also rises as a function of increased income.

The current number of signals in Maputo was given as 80, a number which certainly underestimates the true need for signals based on recent traffic growth. Thus it can be expected that the need and demand for signals will rise exponentially.

This was the case in the 80's in Brazil as the country experienced a similar rise in urbanization and income and it was found that signal numbers reflected both income/car ownership and population size; roughly, doubling the population from 1.5 million to 3 million resulted in an almost threefold increase in signals[3].

When this factor is applied to the expected future population, it can be seen from Table G.6 that the estimated number of junctions warranting signals in Maputo will be around 282 by the time the population reaches 3,500,000. Thus the system should contemplate this new investment in system expansion during the initial build-out phase.

Table G.6: Expected Traffic Signal Growth per Population Increase in Maputo

Approximate Population in Study Area (000's)	Expected Number of Traffic Signals in Maputo
1,500	80
2,000	123
3,000	225
3,500	282

Source: Based on CET: Nota Técnica 080/82, São Paulo

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, 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 on safety below) and with the new options can be banned at the crossings of Karl Marx and Guerra Popular with Eduardo Mondlane and 24 de Julho (see section above).

The major block sizes in the central area vary from about 300 m to 460 m (the layout is in imperial units); for two-way streets this leads to an optimum cycle time (in terms of geometry) of some 70–80s. This will be too short for all the movements and intergreen times, hence, for the peak periods in the medium term longer cycles will be needed – typically around 120–140s.

G.4.7 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 the more thorny questions relating to transport services, such agreements could form the working model for other agreements on similar lines.

[3] CET – Companhia de Engenharia de Tráfego – SP O Uso dos Semáforos no Brasil, Eng.º José Ernesto Lima Gonçalves 15/03/82 Nota Técnica 080/82

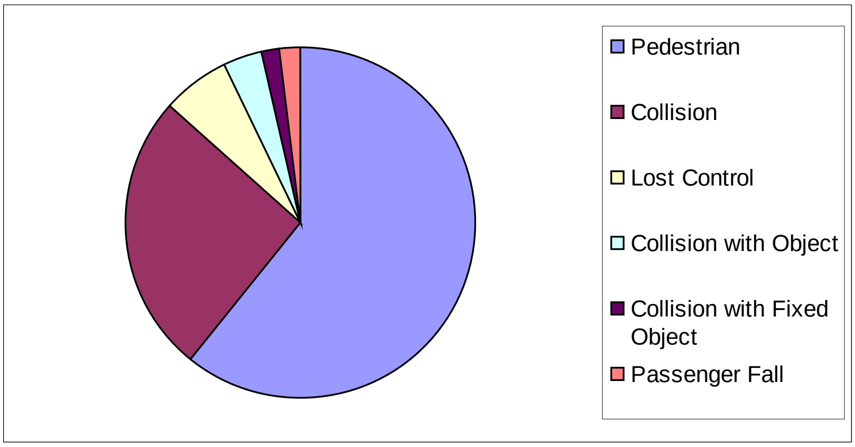
G.5 Traffic Accidents and Road Safety

G.5.1 Overview

The increase of traffic volumes and car ownership has greatly increased the number and severity of accidents, which are recognized as a problem of public health.

The PRM (Polícia Republicana de Moçamibique) headquarters receives and processes accident data that it receives from the 'provincias', but this aggregate does not indicate the locality, hour, etc. that allows for a more detailed analysis. The PRM does, however, have a Maputo Traffic Police specialized office with staff who have complied a digital traffic accident data base.

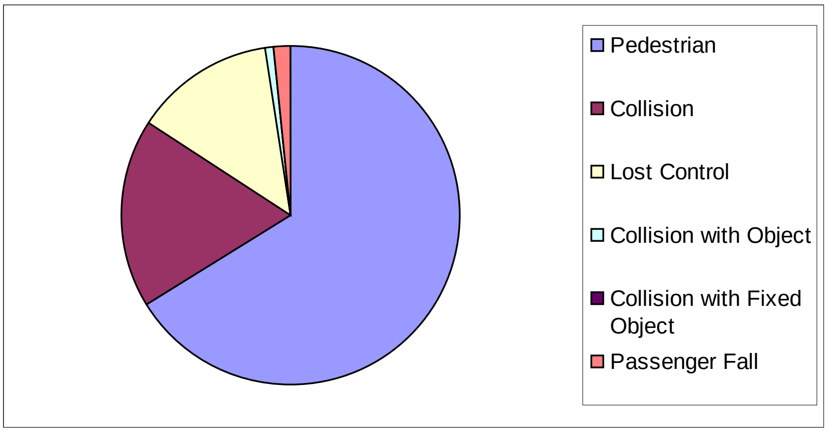
In the years 2011–12 this data indicates that pedestrian accidents are the highest in number, followed by collisions between vehicles.



Source: PRM- Maputo

Figure G.33: Traffic Accidents 2011 by Number

However, when fatalities are considered, the number of pedestrians killed represents some 60% of the total – considering that deaths are recorded on site or at arrival at the emergency centres. Collisions between vehicles and "lost control" or roll-overs count for most of the remaining deaths. The data on serious injuries confirms this tendency, with a similar breakdown by accident type.

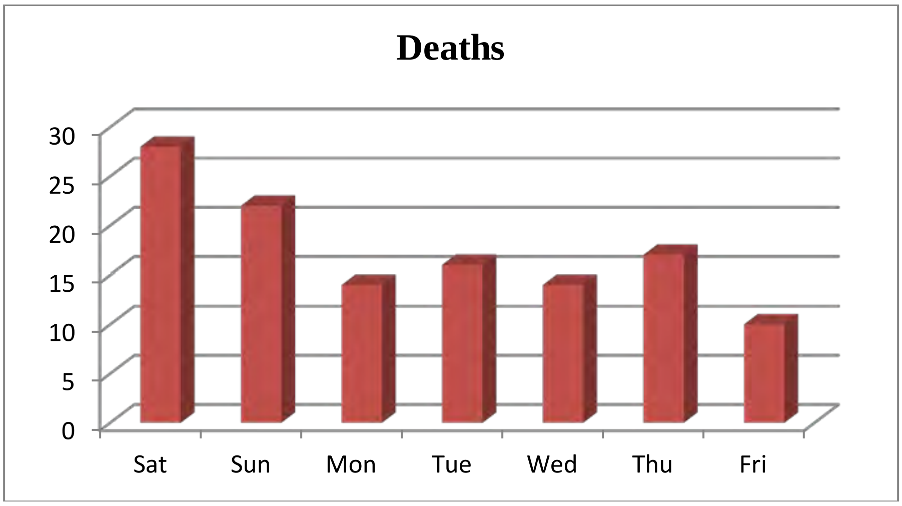


Source: PRM- Maputo

Figure G.34: Traffic Accidents 2011: Fatalities

G.5.2 Accidents: 24/7 – By Day and Hour

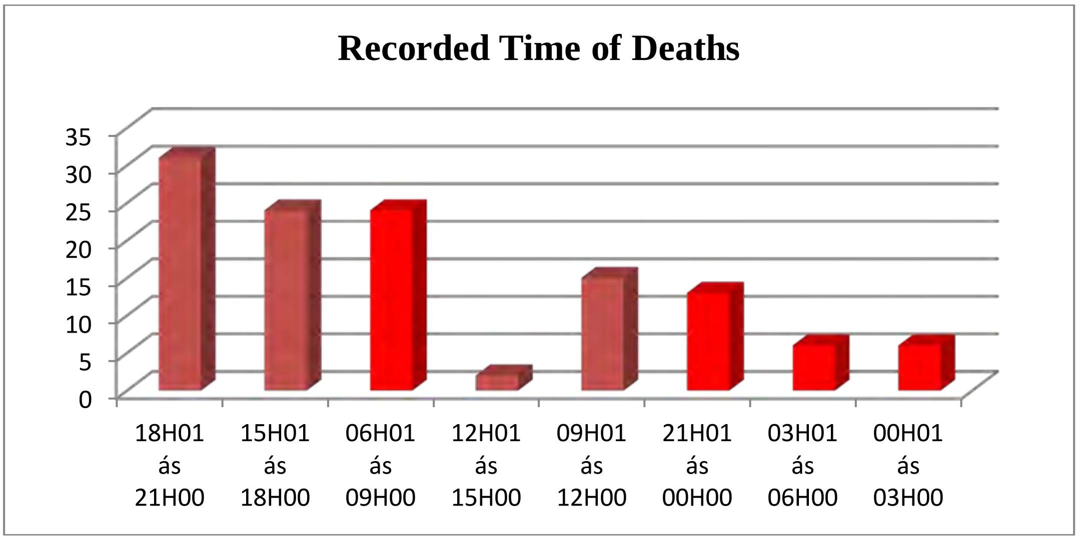
When the data is analyzed by deaths per weekday, it can be seen from Figure G.35 below that there are a disproportional number of accidents over weekends. Although technically any accident past midnight on Friday is classed as happening on a Saturday, in fact, the data clearly shows that the problem is accentuated on Friday and Saturday ***nights*** (considering the night to last until the early hours of the next day).



Source: PRM- Maputo

Figure G.35: Traffic Accidents 2011: Fatalities by Weekday

This is also the pattern when the recorded time of death is shown (Figure G.36). The highest concentrations are in the afternoon peaks – when most pedestrians and drivers are on the streets – followed by the morning peak – when most pedestrians are going to work or coming home. which shows a high number of recorded deaths during the night.



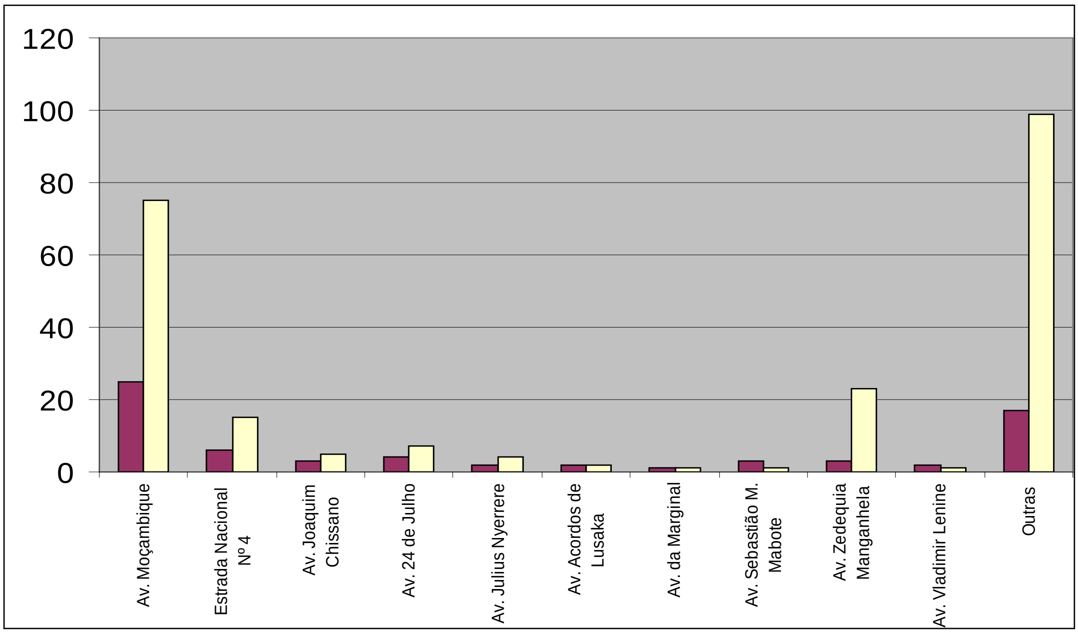
Source: PRM- Maputo

Figure G.36: Traffic Accidents 2011: Fatalities by Hour

It can be noted that his situation is typical of drinking and driving behavior. In many countries drinking and driving culture is now seen in the same light as smoking: a bad, costly and dangerous habit that is no longer socially acceptable.

G.5.3 Accidents: Location

As pedestrian accidents represent the vast majority of all deaths, the Traffic Police examine the principal locations where deaths and serious injuries take place. These are shown in Figure G.37 below (deaths in purple) for the first semester:



Source: PRM- Maputo

Figure G.37: Traffic Accidents 2011 — First Semester: Fatalities and Serious Injuries by Location

As shown above, approximately half of all deaths and injuries took place on Av. Moçambique. Other major and long arteries also had high numbers of accidents: Route N4, Joaquim Chissano, 24 de Julho and Av. Marginal. A large number of serious accidents also occurred on Zedequias Manganhela where there is a high concentration of irregular pedestrian movements due to street vendors and *chapa* traffic.

In order to obtain a higher degree of detail in relation to their exact location a survey was carried out over two days at three of the major emergency hospitals with the PRM staff charged with collecting the accident data. The staff have qualitative information based on months or years of experience and indicated that the main problems of pedestrian accidents are focused, by Hospital, on the following sites:

Hospital Central de Maputo

- Avenida 24 de Julho e esquina com Avenida Karl Max;
- Avenida 24 de Julho esquina com Avenida Guerra Popular (Paragem Entreposto);
- Avenida Eduardo Mondlane cruzamento com Guerra Popular; and
- Avenida Eduardo Mondlane cruzamento com Karl Max.

Hospital de Mavalane

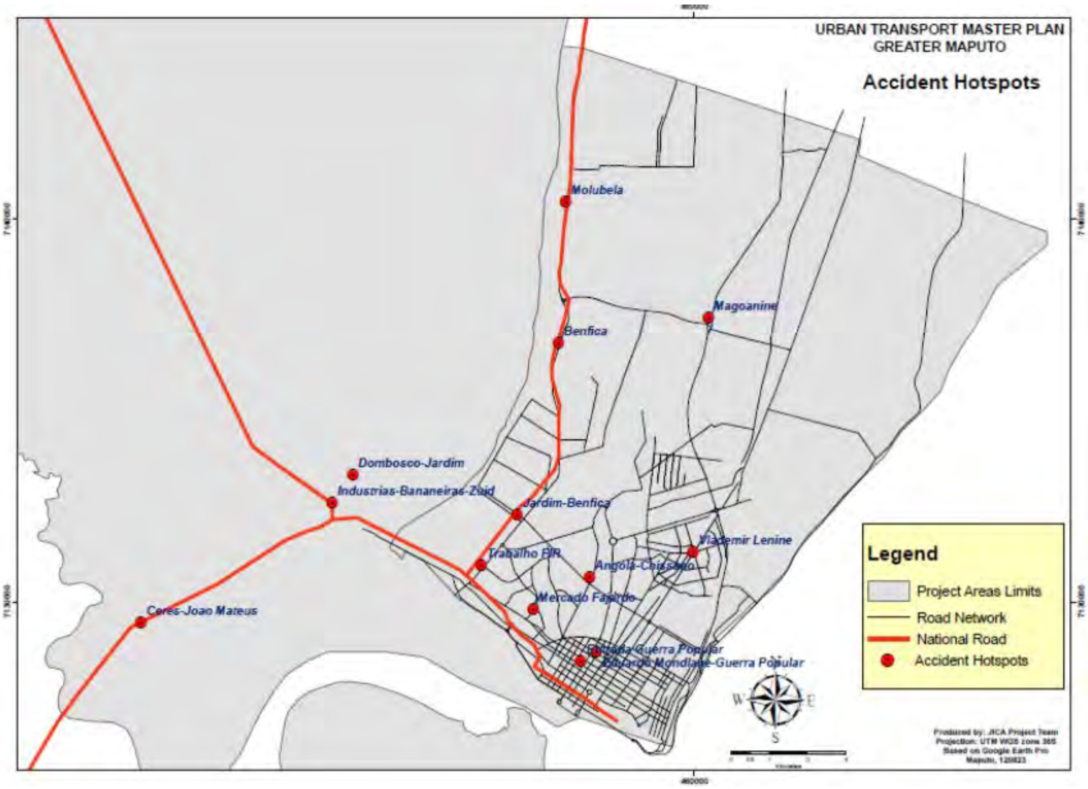
- Avenida Julius Nyerere (Praça da Juventude);
- Avenidas Acordos de Lusaka (Praça dos Heróis, saída da Escola Secundaria Noroeste 1); and
- Praça dos Combatentes (Chiquelene).

Hospital José Macamo

- Maquinac;
- Paragem da Malanga;
- Paragem do Bagamoio;
- Missão Roque;
- Benfica; and
- Mercado grossista do Zimpeto.

These accident "hotspots" are shown in Figure G.38. Many of these locations reflect the conflicts inherent in having large numbers of pedestrians/public transport passengers, street vendors and *chapas* at inadequate terminal or stop facilities on the main road network.

Thus most of the short-term traffic management measures proposed have an important safety component incorporated as part of the project objectives and social impact.



Source: PRM- Maputo

Figure G.38: Traffic Accidents Hotspots

G.5.4 Traffic Safety Proposals

Apart from the inclusion of safety improvements as an integral part of the traffic management measures, some specific additional proposals are required and outlined below.

(1) Digital Data Base

One of the most important proposals is the creation of a unified and digital accident data base which will allow the Metropolitan transport and traffic bodies as well as the PRM to assess the available data and determine the location of accidents, the degree of risk, probable causes and eventual effects of remedial actions.

The supply of software, the training of staff and the initial start-up of an accident data-base 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.

(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 conflict, although for the latter it is not yet clear if the junction will remain open or be closed to E-W traffic. If left open, then pedestrians will continue to use the road space rather than the overpass and the accident hotspot will continue to exist.

The reaction of the local population may also be gauged in terms of damage to the installation (tearing down of fences, etc.) and the level of use of the overpass (generally expressed in the percentage of users on the bridge when compared to people still using the road crossing.

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.

The section of the N4 known as Maquinac has a pedestrian overpass linking the transit stop areas which makes use of the gradient to minimize ramp height, however, many pedestrians still cross making use of the median. This was originally treated 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. In order to minimize glare from on-coming vehicles and discourage "stepping over" this should be slightly higher than the traditional barrier. A recommended design is the California Transport (Caltrans) concrete glare screen and pedestrian fence for median barriers, Type 60G, 60-inch (1,420 mm) high, 24-inch (610 mm) wide at the base and 6-inch (150 mm) wide at the top.

(3) Alcohol Related Accidents

This represents a major cultural challenge for all 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 tackle this problem in terms of legislation, equipment and approach; and in Brazil a similar initiative of: 'Se beber, não dirija' has shown how to handle the questions of public relations and make this an unacceptable social habit.

(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 (the almost universal points system based on registered traffic violations), the Metropolitan Transport Authority may require that the offender undergo a recycling course and pass a new test. Retesting every 5 years or so to guarantee that the driver has the psychological and visual skills will also minimize the presence of poor and anti-social driving. As well as reducing the overall number of private vehicle users, better testing will produce an improvement in the overall traffic culture and smoother and safer traffic flows.

In cultures with high accident rates a very 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 (such as the Volvo Road Safety Programs). Again, this is an area highly suited for technical assistance.

(5) Greater Control of the Fleet

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

(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:

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

G.6 Parking

G.6.1 Overview

Parking Surveys are required in order to understand the usage of existing parking spaces in central Maputo in terms of: occupancy rates, length of stay of cars within bays, availability of bays, demand profile (short/medium/long term) and any relation between demand and time of day. The JICA Project Team carried out parking surveys in the major commercial areas south of the 24 de Julho St. and also divided by operation: paid parking zones (data obtained from the Paid Parking System ‘Rotativo’, managed by a South African consortium – Assessoria, Consultoria & Serviços Gerais – ACSG) and bays still outside the system.

The surveys of unpaid parking were conducted on a normal weekday (Thursday) on a week without any public holidays or festivals. The data on the 'Rotativo' system refers to the month of June 2012 and the data on paid off-street parking reflects the demand of May–July 2012.

The analysis and proposals tend to be for the short and medium term in relation to implementation of paid on-street parking. Those related to legislation on internal off-street spaces and major traffic generators are expected to have an effect over a longer time frame as the city develops.

G.6.2 Unpaid On-Street Parking

The survey of unpaid on-street parking required survey staff to record the number plates of vehicles parked in each parking bay at 30 minute intervals or to indicate if the parking bay is empty or unusable (goods, trash, large pothole, etc.).The raw data was processed into spreadsheet format from the 4 locations chosen (and still not included in the 'Rotativo' System):

- Fernão Magalhães – between Av. F. S Magaia and Av. Karl Marx
- Timor Leste – between Av. Samora Machel and the Travessa
- Felipe Samuel Magaia 1 – between Av. Josina Machel and Av. Ho Chi Minh
- Felipe Samuel Magaia 2 – between Av. Ho Chi Minh and Av. 24 de Julho

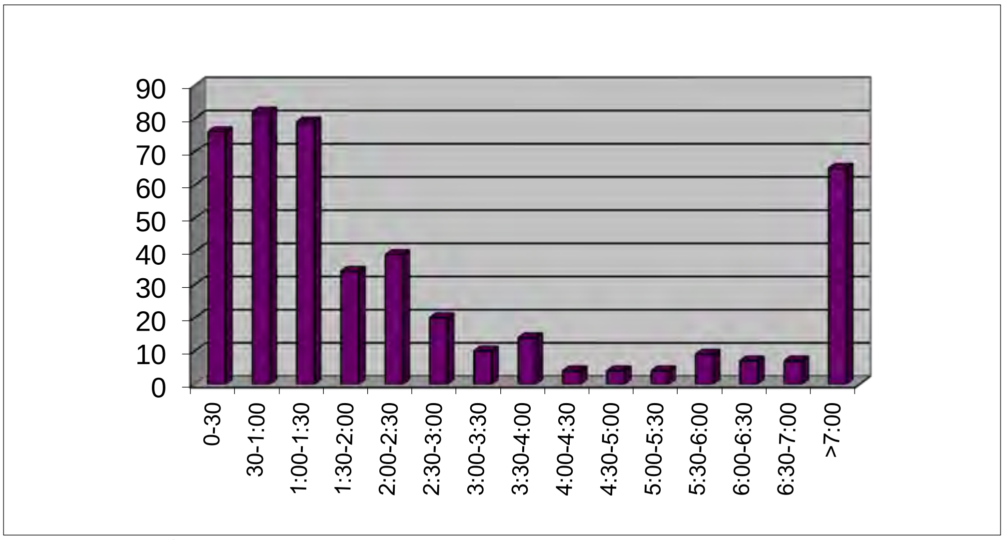
The results are shown in Table G.7 in which one annotation is taken to signify a half hour stay, two and hour and so on.

Table G.7: Duration of Unpaid Parking in the Central Area

Duration	Fernão Magalhães	Timor Leste	F S Magaia 1	F S Magaia 2	Total	Occupied Time
0–30	42	3	13	18	76	38
30–1:00	37	5	20	20	82	82
1:00–1:30	34	2	17	26	79	118.5
1:30–2:00	19	1	9	5	34	68
2:00–2:30	14		15	10	39	97.5
2:30–3:00	9		2	9	20	60
3:00–3:30	4		3	3	10	35
3:30–4:00	5		5	4	14	56
4:00–4:30	1	1	1	1	4	18
4:30–5:00	3			1	4	20
5:00–5:30	2		2		4	22
5:30–6:00	2		2	5	9	54
6:00–6:30	5	1	1		7	45.5
6:30–7:00	3	2	1	1	7	49
>7:00	11	28	16	10	65	520
Bays	70	35	52	67	224	1,283.5

Source: JICA Project Team

The results show in Figure G.39 below that there is a strong short-term demand of up to some two hours coupled with a high long term (over 7 h) demand.



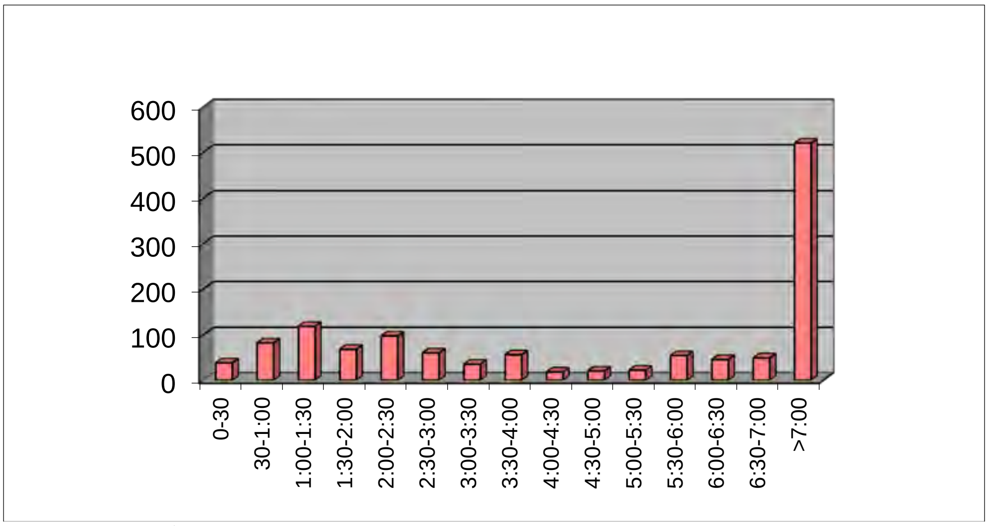
Source: JICA Project Team

Figure G.39: Parking Duration in the Unpaid On-Street Locations: Total Cars per Period

(1) Provision of Parking Bay-Hours

The city provides a service not just in parking bays***, but in a unit which can be termed bay-hours***, in other words the sum of the total number of working hours times the number of bays.

When occupation of these is considered it can be seen in Figure G.40 that long term parking occupies almost half of the available bay-hours (taken in this case as being represented as an average of eight hours). Thus the short-term parking demand – vital to the economy of a commercial and service centre – is kept in relatively short supply.



Source: JICA Project Team

Figure G.40: Occupation of Bay-Hours in the Unpaid On-Street Locations

The total occupancy rate of all bay-hours was 64%. No bays were reported as being occupied by trash or other obstacles. Bays on Felipe Samuel Magaia tended to become vacant in the mid-afternoon when the adjacent public sector employees left work.

The total turnover rate or rotation (parked cars per bay) was 2.03 i.e. an average bay serves two clients per working day.

G.6.3 Paid On Street Parking – The 'Rotativo' System

According to data for the month of June 2012 as supplied by the 'Rotativo' operator, a total of 1,329 parking spaces were under the scheme according to their zonal division and shown in Table G.8 and on Figure G.41.

Base map: Google Maps
Source: JICA Project Team

Figure G.41: 'Rotativo' System Parking Bays by Operational Zone, June 2012

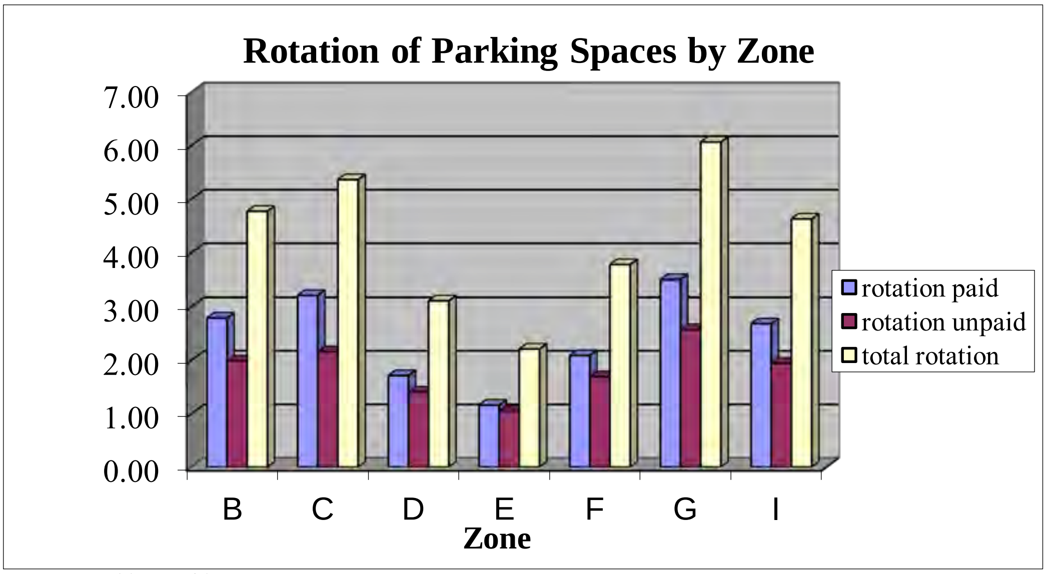
These bays had a total of 470,550 paying and complying customers and another 349790 customers that either did not pay or overstayed. In the former the rotation per total spaces was 2.36, ranging from 3.5 in zone G to 1.15 in the area around zone E.

The unpaid rotation was lower, ranging from 1.05 to 2.57 in the same zones. Total rotation was 4.12, ranging from 2.2 in zone E to around 6 in zones C and G. These values are shown in Figure G.42 below.

Table G.8: 'Rotativo' Parking Bays in Operation June 2012, Rotation by Paying and Non-Paying Clients

Area	B	C	D	E	F	G	I	Total
Spaces	79	340	174	212	241	32	251	1,329
Paid	32,980	163,450	44,590	36,680	75,290	16,760	100,800	470,550
Paid rotation	2.78	3.20	1.71	1.15	2.08	3.49	2.68	2.36
Unpaid	23,520	109,840	36,450	33,390	61,010	12,330	73,250	349,790
Unpaid rotation	1.98	2.15	1.40	1.05	1.69	2.57	1.95	1.75
Total Rotation	**4.77**	**5.36**	**3.11**	**2.20**	**3.77**	**6.06**	**4.62**	**4.12**

Source: Parking4Africa



Source: Parking4Africa

Figure G.42: Rotation of Paid On-Street Parking Spaces by Zone

If the system were fully operational, with all spaces rolled-out, firmer enforcement and higher compliance, the turn-over rate for all bays would average about 6 clients per bay/day – a value similar to most short-term on-street parking systems worldwide.

There are still many commercial zones in which short-term parking could be favoured and which are labeled (‘X’) in Figure G.41. If a pre-system turn-over value of 2 is used (as indicated by the surveys), then Rotativo system would imply in tripling the number of users using the bay-hours offered by the city. Using an estimate of 1,600 bays for the roll-out phase of south of 24 de Julho, the number of users would go from some 3,200 to 9,600 per day.

G.6.4 Off-Street Parking

As yet there is very little off-street parking within the main commercial zones due to perception that on-street bays are available and largely free and that sidewalks can be used with impunity for parking.

According to the Rotativo system operator, some vacant or abandoned lots are now being informally operated as parking areas, as the users become aware that long-term parking is now becoming less of an option within the zones covered by the Rotativo system.

(1) The ‘Mercado’

This site has some 220 spaces (depending on the size of the vehicles and obedience of the layout markings) and is located next to the Central market and shopping mall. The system is managed under contract by the company Intermesch (21301500) and offers around 75% of the spaces under monthly contracts:

Values in meticais

	Individual Rate	Corporate Rate
24h	3,250	4,500
Night time only	1,750	2,500
Day time only	2,750	3,500

Source: Intermesch

The remaining spaces are costed at a minimum price of 20 MT for up to 1 hour, rising as permanence increases.

Data on the rotation, average time per space and availability of spaces was requested from the data bank of the operator and this revealed that between May and July 2012 there was an average of 500 short-term/work day clients for the 50 bays open to the public: a rotation of 10 users/bay. About 70% of users stay less than one hour, the remainder stays up to 3 hours.

Demand is higher in the mornings around 10 am and peaks at the end of the month. Since the implementation of the Rotativo System there has been a marked increase in the demand for monthly contracts and the company no longer accepts new monthly clients.

The company has interest in building a parking garage and commercial building on the site and has prepared the engineering drawings.

(2) Vacant Lots

The two vacant lots in the city centre examined are on the corner of Av. Karl mark and Av. Josina Machel. These are ‘controlled’ by ‘car-minders’ who also wash the cars. An all-day ‘charge’ of 10 MT per car was the standard at these lots.

To the north, on Av. Karl Marx and Av. Ho Chi Minh a paved parking area is under construction that, according to the DMTT, may be operated by concession.

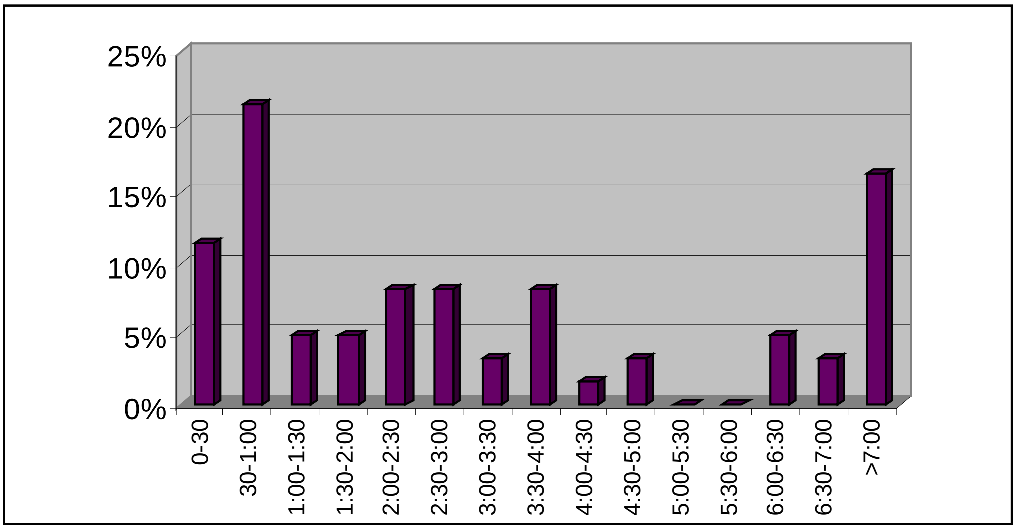
G.6.5 Sidewalk Parking

Four sites were chosen to assess the behaviour of drivers who park on the sidewalks (defined as abusive behaviour in the new Highway Code), in particular the distribution of the time spent blocking the sidewalk.

These sites were:

- Av. Lenine: Av. 24 de Julho – Av. Ho Chi Minh – west sidewalk;
- Felipe Samuel Magaia: Fernão Magalães – Zedequias Manganhela – west sidewalk;
- Olaf Palme: Av. 24 de Julho – Av. Eduardo Mondlane – south sidewalk; and
- Karl Marx: Av. 25 de Setembro – Zedequias Manganhela – east sidewalk.

The results of an average workday are shown in Figure G.43:



Source: JICA Project Team

Figure G.43: Duration of Sidewalk Parking by Percentage of Cars Surveyed

This distribution is similar to Figure G.39 above and indicates that sidewalks are simply considered as an extension of parking areas for both short-term and long-term parking.

G.6.6 Proposals for Short and Medium Term Parking

(1) Expansion of the 'Rotativo' System

This 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 roll-out of the proposed zones south of 24 de Julho, the existing areas could be gradually augmented by 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 'cruising' as users 'trawl' in search of a space.

(2) Special Access and Other Reserved Bays

In time, the system should introduce the concept of bays reserved specifically for vehicles adapted for people with special needs or over a certain age.

(3) Sidewalk Parking

This has become widespread. Residents, in particular, 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 – as of 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 movement due to cars and trucks obstructing the sidewalk.

Sidewalk maintenance is also a major problem which is exacerbated by the passage of (and consequent damage 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 not carried out, this 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, as shown in Figure G.44, from Rio de Janeiro. This technique is already used in front of several buildings based on local initiative, such as the British Council building, but the questions of sidewalk maintenance, obstructions to high pedestrian flows and the regularized use of bollards need to be clarified.

Source: JICA Project Team

Figure G.44: Bollards (Fradinhos) to Prevent Sidewalk Parking in Rio de Janeiro, Brazil

G.6.7 Proposals for Regulation on Parking and Land Use

Although strictly outside the scope of traffic management, the second workshop raised the questions of how to incorporate parking needs within land use ordinance, specifically, the situation of major traffic generators and parking by proposed land use (Planning Permission). The following items seek to address these issues.

(1) Parking and Land Use

Given the present and predicted 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 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.
And to facilitate pedestrian movement it is necessary to separate vehicle access to large parking areas.

A bay should correspond to 25 m² (twenty-five square meters), including the access, movement and maneuvering spaces.

There should be reserved parking spaces for disabled people, duly identified for this purpose, near the entrance to the building of public use, with minimum width of 3.50 m. (three meters and fifty centimeters), in the following proportion:

- Up to 50 bays, 1;
- From 50 to 100 bays, 2;
- From 100 to 200 bays, 4; and
- Above 200 bays, 1 for each 100 bays or fractions.

The following standards must be met: minimum dimensions of bays: 2.40 m (two meters and forty centimeters) wide and 5.00 m (five meters) in length, free of any obstacle. Non covered parking lots should also have trees planted at a ratio of one tree for every four bays in order to guarantee permeability, shade and landscaping.

The access corridors and circulation of vehicles should have the following minimum widths, according the angle formed in relation to bays:

- in parallel – 3.00 m;
- up to 45 degrees – 3.50m; and
- between 46 degrees and 90 degrees – 5.00m.

Access to parking lots greater than 250 m squared must have independent access for vehicles and pedestrians, with minimum width of 3 m for one-way access and two-way access between 5 m and 7 m in width. When parking capacity exceeds 30 bays, inbound and outbound accesses should be independent or two-way. Ramps for access to garages cannot start less than 3.50 m from the building alignment.

The following table is a guide to the number of spaces required by land use characteristic and total built area and is based on the experience of Brazilian cities undergoing rapid development.

Table G.9: Parking Standards by Land Use

Habitation		
Single Family houses		1space per unit
Town houses (undetached)		1space per unit
ApartmentBlock1bedroom		1space per unit
Apartment Block 2 or more bedrooms		1space per unit
Commercialor Service Sector		
Catering/Food	butcher, bar, baker, fish, deli, ice-cream parlour	1 space per 100 m^2 of built area min 2 spaces
Various	chemists, flower stall, paper and magazine stall	1 space per 100 m^2 of built area
Local Commercial Center and Shopping Malls		1 space per 100 m^2 of built area
SpecializedCommerce		
doctors, dentists, car dealers, motorbike dealers, opticians. Tailors, dressmakers and other professional offices		1 space per 50 m^2 of built area
Commerce of Large Scale Materials		
construction, stone deposits, boatbuilding, marine engines, truck and bus dealers and servicing		1 space per 50 m^2 of built area
DangerousMaterials		
gas, gasstations, petrochemicals		1space / 100 m^2 de area
Buisiness		
Offices		1 space per 50 m^2 of built area
Health	Clinicsandlaboratories	1 space for embarking + 1 space per 50 m^2 of built area
Education	health clubs, driving schools, professional courses	1 space per 50 m^2 of built area
Hotels, Bed&Breakfast		
		1space/ every 2 units

Sources: Parking Guidelines in Brazilian Cities – Curitiba, São Paulo, Joinville, Belo Horizonte

(2) Treatment of Major Traffic Generators

Certain developments may impact the structure of the city due to their size, nature or location, which may be significant change on the environment, neighborhood, traffic flows, public transport system and traffic safety. In these cases a Neighbourhood Impact Study (NIS) is often required in many cities.

The projects subject to a NIS are normally those over 5,000 m^2 and of the following land uses:

a) Shopping centers and department stores;
b) Hypermarkets and supermarkets;
c) Educational establishments;
d) Hospitals, emergency treatment, maternity hospitals and medical clinics;
e) Stadiums, racetracks and racecourses;
f) Hotels;
g) Restaurants, cinemas, theatres, temples, churches and auditoriums;
h) Industries;
i) Residential condominiums;
j) Office buildings;
k) Airports and ports.

The NIS will contemplate the positive and negative effects of the project or activity as to the quality of life of the population resident in the area and its vicinity, including the analysis of the following issues:

a) Population density;
b) Urban and community equipment;
c) Use and occupation of land;
d) Real estate valuation;
e) Traffic generation and demand for public transport;
f) Ventilation and lighting;
g) The urban landscape and natural and cultural heritage.

In the case of private enterprises, the NIS should be prepared by the entrepreneur. In the case of public enterprises, the Study should be prepared by City Hall assisted by the municipal council.

To ensure popular participation, the analysis and its opinion of the NIS must be preceded by publication of documents available for consultation.

The NIS normally includes:

a) Detailed description of the project or activity;
b) Presentation of preliminary plans;
c) Delimitation of the areas of direct influence of the activity, the extent of public roads that limit the area and extension of access routes, for the assessment of impacts on the road and the public transport system as well as an assessment of the impacts on the landscape, existing human activities and on natural resources;
d) Identification of impacts to be caused during the phases of planning, implementation, operation and decommissioning, if applicable; and
e) Control measures, compensatory or mitigating impacts to be adopted at the various stages.

G.7 Traffic Demand Management (TDM)

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 Greater Maputo Study Area will tend to focus on TDM as a tool to curb traffic congestion as this becomes critical to the point of damaging the local economy and imposing on the very quality of life. Accessibility will be guaranteed for good and persons through the road system improvements and basic traffic management, such as the CCO traffic signal scheme.

Table G.10 below shows the most adopted traffic related TDM measures

Table G.10: Description of Management/Policy Measures (Traffic-Related)

Measure	Description of Measure
a) Traffic Calming Measures	Traffic calming measures are designed to improve safety and to reduce environmental impact of automobile usage, traditionally focusing efforts upon residential streets: • “Segregation” measures reduce extraneous traffic and include the implementation of one-way roads, closure of others, and banned turns • “Integration” measures encourage traffic to operate at reasonable, safe speeds, while respecting the environment and surrounding residents, consist of among others the adoption of low speed limits, speed bumps, rumble strips, chicanes, etc.
b) Private Vehicles Restrictions	Restrictions on private vehicles may include limiting the number of new vehicle permits issued each year (Singapore) or the prohibition of certain vehicles from urban areas on certain days based on their license plates (adopted in large cities such as Athens, São Paulo, Mexico City and Lagos)
c) Parking Control Regulations	Measures include reductions in parking space capacity (either on-street or in public lots), shortened parking duration limits, reduced “operating hours”, as well as requirement of parking permits in specific areas
d) Car-Pooling	Goal is to place would-be individual drivers into a single car heading to a common direction to reduce the number of vehicles on the roadways Benefits for participants include lower fuel costs and vehicle usage/ mileage. Infrastructure such as park-and-ride lots maybe be needed
e) High-Occupancy Vehicle (HOV) Lanes	Special lanes, designated for use by high-occupancy vehicles (usually three or more people, but in some cases two or more) at certain times of the day (usually during peak periods) Reduces total number of vehicles on the roadway and makes travel quicker for drivers and passengers in HOV, encouraging drivers to abandon single cars and use car-pools

Source: JICA Project Team

Of these measures, parking is being adopted. For the medium term, the simplest TDM measure is the use of license plates to control circulation.

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.

Car-pooling is undergoing a revolution as smart-phone applications become widespread and the risks of associating with members of the same system are reduced. Several applications (apps) are in use in Europe and Latin America and may catch on in Moçambique; although there is little that the administration can do to promote this mode.

Table G.11 below indicates the Pricing strategies that can be used to promote TDM:

Table G.11: Description of Pricing/Fare Level Measures (Automobile-Related)

Measure	Description of Measure
a) Parking Fees/Lots/Meters	Higher parking charges or more prevalent adoption of parking meters are intended to decrease congestion within urban areas and make driving into congested areas less convenient, to reduce private vehicle usage and change inherent travel usage patterns
b) "The Workplace Parking Levy"	A scheme to enable local authorities to levy charges on all private parking at workplaces, based on the number of parked vehicles or available spaces. The objective is to reduce automobile-based commuting and ease traffic congestion
c) Urban Road Pricing	Scheme to limit traffic entering central areas with high traffic congestion and to reduce traffic congestion and eliminate non-essential drivers from central areas Tolls may vary by time of day, degree of congestion, and vehicle type Successful applications, especially in Singapore, uses SMART card system to automatically debit passing vehicles, eliminating the need for toll booths Toll revenues may be put to use for transport infrastructure improvement

Source: JICA Project Team

In the Maputo area it is envisaged that parking costs will increase and that the total revenues (fees and fines) will be used to improve overall transport standards.

A levy on workplace parking is not considered to be feasible or practical over the study period.

Road Pricing systems of the London Congestion Charge or the Singapore type are relatively complex to install and control. Instead of charging for the road when the car is motion, it is much simpler to charge the vehicle when it is parked on public streets or when using a stretch of highway (tolls). Both tolls and parking charges are now part of the local traffic culture and – if required – new toll roads could be considered, such as the proposed alternative to the N1 (allowing this existing highway to be upgraded to BRT).

National measures related to TDM pricing are shown in Table G.12. These measures are of specific interest to Greater Maputo as this relates to the nation's capital city. Measure a) can be considered as the road tax. Item c) is unpopular and can be seen as 'anti-business' and unpopular in the present economic atmosphere. Item b) has been used in many major cities to finance specific projects, such as the Transmilenio in Bogotá. Public acceptance tends to be higher as the projects are seen to be local and fulfilling a local need.

Table G.12: Description of Pricing/Fare Level Measures (Tax-Related)

Measure	Description of Measure
a) National Vehicle Ownership Tax	Taxes applicable on purchase of new vehicles, which are intended to stunt or limit growth of vehicle ownership, especially in areas with congested roadways and limited expansion space Major source of revenue that for transport infrastructure improvement
b) Fuel Tax	Fuel taxes intended to make driving more expensive and encourage public transport usage as well as to reduce environmental impact and to encourage economical usage of vehicles Tax revenues may be applied to transport infrastructure improvement
c) Company Vehicle Ownership Tax	Intended to apply same tax stipulations on companies for purchase of vehicles as those placed on purchase private vehicles, encouraging business to think rationally about purchases

Source: JICA Project Team

For Greater Maputo the most important proposed medium and long term TDM measures needed are:

a) **Better Quality Public Transport**. Quality public transport that can offer a viable substitute for costs of using the private car 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 etc, free from traffic congestion and thus with faster journey times than the car 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, thus long-term parking will became scarcer and more expensive and walking times longer. This 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 check-point downstream the systems allow for only vehicles with large debts to be stopped. This also permits the use of certain numbers on specific days, for example: numbers ending in 1 and 2 must not travel within the congested zone on Mondays, 3 and 4 on Tuesdays and so on.

G.8 Phasing Summary

The following series of tables set out a summary of the main measures in a short, medium and long term phasing plan:

Table G.13: Short Term Traffic Management Measures

Ref	Measure	Examples	Short Term	Med Term	Long term
TM1	Junction improvements	• Access to Av. Indústrias/Bananeiras (roundabout) • A few other junctions	✓		
TM2	Public transport priority/improvements package	• N1 improvements • Av Angola (2 projects) • Transit only section n Av Guerra Popular	✓		
TM3	Improved access to new suburbs (“Bairros Populares”) along the main highways	• Benfica Bolsãos • Choupal Bolsãos • Zimpeto	✓		
TM4	Short term road development and urban structuring measures	• Av. Lenine binary system • Hulene Expresso/ Magoanine (Rail RoW Link to Cardeal Alexandre dos Santos)	✓		
TM5	Linking new projects with the existing road network	• Av. Marginal, Access to Av. Julius Nyerere and Kenneth Kaunda Junction	✓		

Source: JICA Project Team

Table G.14: Traffic Signal Measures

Ref	Measure	Examples	Short Term	Med Term	Long term
TM6	Warrants for signals	• clear set of warrants to be implemented to justify the use of signals	✓		
TM7	Package of conflicting right turn schemes	• Priority for Guerra Popular • Avenidas Karl Mark and Eduardo Mondlane	✓		
TM8	Area Traffic Signal Control System	• Adaptive Signal Control (ASC) type system, • Operational Control Centre (CCO) • BRT priority	✓	✓	
TM9	Medium term traffic signal expansion	• Expansion of signal system approximately 200 signals	✓	✓	
TM10	Bilateral agreements on maintenance/ timings	• Agreement regarding responsibilities for signal timings and maintenance ion Greater Maputo	✓		

Source: JICA Project Team

Table G.15: Traffic Accident and Road Safety Measures

Ref	Measure	Examples	Short Term	Med Term	Long term
TM11	Digital Data Base	• Digital traffic accident database	✓		
TM12	Pedestrian Measures at accident hotspots	• Package of measures	✓		
TM13	Alcohol Related Measures	• Specific programs such as the 'Arrive Alive' program	✓		
TM14	Better driver training and education	• Sticker driving testing and standards • Measures to tackle alcohol related accidents • Safer driving courses and training	✓		
TM15	Greater control of the fleet	• stricter technical revision of the quality of the vehicles in circulation	✓	✓	
TM16	Electronic enforcement	• Speed controls at accident 'hotspots' (e.g. electronic 'speed humps'); • Weight controls on highways • Invasion of BRT lanes; • Electronic breath testers for checks on drinking and driving		✓	

Source: JICA Project Team

Table G.16: Parking Measures

Ref	Measure	Examples	Short Term	Med Term	Long term
TM17	Expansion of 'Rotativo' system	• Addition of new areas after full roll-out of the proposed zones south of 24 de Julho	✓	✓	
TM18	Special access and other reserved bays	• Introduce concept of Special access and other reserved bays	✓	✓	
TM19	Sidewalk parking	• Package of measures, may include physical barriers in extreme cases	✓	✓	
TM20	Regulation on parking and use	• Parking and land use standards • Parking considerations at major traffic generators	✓	✓	

Source: JICA Project Team

Table G.17: Traffic Demand Management (TDM)

Ref	Measure	Examples	Short Term	Med Term	Long term
TM21	HOV lanes	• Pilot projects on the coast toll road and Katembe bridge		✓	
	Better quality public transport	• Wider package of public transport improvements	✓	✓	✓
	More short-term parking supply	• Parking system in operation will be rolled-out into new districts over time (form of road pricing)		✓	✓
	Controls over road taxes and fines	• including controls 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.		✓	✓

Source: JICA Project Team

Technical Report H

Financing Options and Strategies

Contents

Figures

Tables

Technical Report H Financing Options and Strategies

H.1 Introduction

The capital investment program included with the Comprehensive Urban Transport Master Plan for the Greater Maputo (the Master Plan) calls for MT 100.1 billion in investment through 2035 (constant prices, MT 166.0 billion in nominal prices) (USD 3.3 billion/USD 5.4 billion). When future capital expenditure requirements and existing public transportation expenditures of the Greater Maputo communities are added the financing requirement is MT 170.8 billion (constant prices, USD 5.6 billion). Table H.1 summarizes the financing requirement.

Table H.1: Master Plan Financing Requirement[1]

Unit: USD million

	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Yr. 5	Years 6–10	Years 11–23	Total
MP Project expenditures	12.5	57.6	184.2	183.8	188.5	973.6	1,682.9	3,283.1
Maintenance Capital Expenditures	4.6	4.7	4.7	4.8	4.9	27.6	353.6	404.8
Operating and Maintenance Expenses	39.6	39.5	39.5	39.6	39.7	205.5	557.8	961.3
PPP Support Payments	--	--	--	--	--	217.3	494.8	712.1
Debt Principal and Interest Payments	--	--	0.1	0.2	0.2	25.2	226.3	252.1
Total	**56.6**	**101.8**	**228.5**	**228.5**	**233.4**	**1,449.2**	**3,315.5**	**5,613.4**

H.2 Financing Strategies for Master Plan Implementation

An effective financing strategy includes the following elements:

- Supports implementation of priority projects on a planned, reasonable schedule.
- Utilizes a mix of financing vehicles to achieve a low effective cost of financing and manage annual cash obligations.
- Matches 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).
- Includes procedures to collect and analyze performance data to monitor progress and outcomes and adjust activity as appropriate.

Table H.2 details the proposed financing plan for the Master Plan project investments and other requirements presented in Table H.1.

[1] Constant 2012/2013 prices

Table H.2: Master Plan Financing Plan Summary[2]

Unit: USD million

	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Yr. 5	Years 6–10	Years 11–23	Total
Local funds	21.5	47.9	117.0	118.2	120.4	406.3	1,135.7	1,966.9
Central Government Transfers	21.2	39.9	97.4	88.4	90.5	329.5	1,259.4	1,926.2
Operating Revenue	14.0	13.9	14.1	14.4	15.1	82.3	233.0	386.8
PPP Capital	--	--	--	7.5	7.5	266.0	674.4	955.4
PPP Concession Payments	--	--	--	--	--	4.4	12.9	17.4
External Funds	--	--	--	--	--	360.7	--	360.7
Total	**56.6**	**101.8**	**228.5**	**228.5**	**233.4**	**1.449.2**	**3,315.5**	**5,613.4**

Table H.3 discusses financing vehicles that can be considered for the Master Plan projects.

Table H.3: Financing Vehicles

Financing Vehicle	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.[3]	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).[4]	Mozambique's government borrowing rate as of the end of the third quarter of 2012 was 3.0% for a 90-day T-bill[5]. Recent sales of 3-year bonds and 5-year bonds were priced to yield about 10% and 17%, respectively.[6]	Pluses: availability of funds, transparent terms and procedures; Minuses: high cost, relatively short amortization periods	Refinancing risk because of short amortization periods, high interest rates' effect on budget
Development financing	Single country and multi-lateral development financing organizations provide grants and loans to support global development; generally sector specific funds; typically fund 50%–85% of total project cost; usually available for capital items only, expense items not eligible	Loan financing available on extremely attractive terms: 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; Minuses: can require substantial matching funds; bureaucratic	Passage of time increases project cost; failure to raise matching funds/failure to gain internal approval for loan

2 Constant 2012/2013 prices
3 *Fundo de Iniciativa Autárquica (FIA)* funded by transfers from the central government
4 Calculated from IMF figures: Fifth Review under Policy Support Instrument, 3 January 2013, Table 1, page 19.
5 Ibid, Table 4, page 22
6 Reuters, 22 August 2012, http://www.reuters.com/article/2012/08/22/mozambique-bond-idAFL6E8JM5IJ20120822

Financing Vehicle	Description	Cost	Pluses/Minuses	Risks
			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 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 fail

Source: JICA Project Team

H.3 Public Financing in the Transport Sector

The public financial system in Mozambique consists of three different geographical dimensions, namely:

- Central government organizations, including 23 ministries;
- 43 Municipal authorities, which became the full autonomy in terms of administration, finance, and property by the Law 1/2008; and
- Deconcentrated local state organs, including 128 districts and 11 provinces.

In addition to the geographical division, the state budget is transferred to: 1) Autonomous institutions of the state, which enjoy financial autonomy from the state and which undertake non-commercial activities (for instance, Road Fund); and 2) Public companies, which receive a subsidy or transfer from the central government (for instance, Maputo Public Transport Company: TPM). This Appendix describes the public financial system in the transport sector at the central government level, and then reviews the budget and expense related to the transport sector in municipalities and at the district level.

H.3.1 Allocation of State Budget in the Transport Sector

Financial resources of the central government in Mozambique have been determined according to strategic objectives and priorities identified in PARP (Plano de Acção Para Redução da Pobreza: 2011–2014). PARP (2011–2014) emphasizes the importance of increasing revenue collection through the decentralized system (See Appendix D). The priority actions identified in PARP will be implemented and financed in the program described in the Medium Term Fiscal Framework (MTFF), whose financial allocation will be elaborated annually in the Economic and Social Plan (PES) and the State Budget (*Orçamento do Estado*: OE). Eighty eight programs were selected as priority actions for achieving the objectives of PARP; around 57% to 60% of the total state budget will be allocated for the priority programs between 2011 and 2014.

Table H.4 shows the distribution of investment resources determined in the MTFF 2012–2014. Within the strategic objective of "Increase Output and Productivity in Agriculture and Fisheries", the investment in the transport/road sector comprises around 23% of the total investment between 2012 and 2014. Among the investment in the transport/road sector, externally funded resources consist of 85% of the total investment, which implies a heavy dependence on external funding for the investment in the transport/road sector in Mozambique. In fact, external resources account for 73% of the total investment in the government of Mozambique in 2011. Therefore, the investment for the transport sector is not stable nor regularly provided, but depending on the provision from external resources. The priority programme of "Rehabilitation and Improvement of Roads" accounts for MT 6,006 million or around 11.3% of the total investment, followed by the "Development of Transport System" (MT 5,305 million, 10% of the total investment) and the "Construction and Rehabilitation of Bridge" (MT 816 million or 1.5 of the total) in 2011.

The State Budget in 2012 allocates 66.7% of the total investment budget for the Priority Sector identified by PARP, in which the road sector comprises 9.5% of the total budget (Table H.5).

Table H.4: Distribution of Investment Resources in MTFF 2012–2014: Selected Strategic Programs

Unit: MT million

Strategic Program	2011 (OE)			2012 (MTFF)			2013 (MTFF)			2014 (MTFF)		
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total
1. Increase Output and Productivity in Agriculture and Fisheries	5,651.9	15,409.1	21,061.0	6,513.3	16,518.6	23,031.9	7,421.4	17,443.6	24,865.0	8,448.3	18,420.5	26,868.8
Construction and Rehabilitation of Bridge	384.7	431.5	816.2	443.3	462.6	905.8	505.1	488.5	993.6	575.0	515.8	1,090.8
Development of Transport System	431.5	4,873.9	5,305.4	497.3	5,224.8	5,722.0	566.6	5,517.4	6,084.0	645.0	5,826.3	6,471.3
Rehabilitation and Improvement of Roads	976.8	5,029.2	6,006.0	1,125.6	5,391.3	6,517.0	1,282.6	5,693.3	6,975.8	1,460.0	6,012.1	7,472.1
Total of Transport	1,793.0	10,334.6	12,127.6	2,066.2	11,078.7	13,144.8	2,354.3	11,699.2	14,053.4	2,680.0	12,354.2	15,034.2
Percentage of Transport	12.3	26.8	22.8	13.1	26.7	23.0	14.6	26.6	23.4	14.8	26.5	23.2
2. Human and Social Development	499.1	12,879.6	13,378.7	575.2	13,807.0	14,382.1	655.4	14,580.1	15,235.5	746.1	15,396.6	16,142.7
3. Promotion of Employment	154.1	62.3	216.5	177.6	66.8	244.4	202.4	70.6	272.9	230.4	74.5	304.9
Strategic Program of Urban Poverty Reduction	140.0	0.0	140.0	161.3	0.0	161.3	183.8	0.0	183.8	209.3	0.0	209.3
Total for PARP Objectives Central	7,482.5	34,514.2	41,996.2	8,689.8	37,016.1	45,705.9	9,900.6	39,227.8	49,128.4	11,806.7	41,567.9	53,374.6
Others	7,104.2	4,107.9	11,212.1	7,049.8	4,416.0	11,465.8	6,185.7	4,764.9	10,950.5	6,328.1	5,136.5	11,464.6
Total Investment for Central Government	14,586.8	38,622.1	53,208.9	15,739.6	41,432.1	57,171.7	16,086.2	43,992.7	60,078.9	18,134.8	46,704.4	64,839.2

Source: GOM, Cenário Fiscal de Medio Prazo 2012–2014, 2011

Table H.5: Percentage of Expenditure in Priorities Identified in PARP

Unit: %

	2011 OE	2012 Proposed
Education	16.5	18.2
Health	7.0	7.8
HIV/SIDA	0.1	0.1
Infrastructure	13.9	13.4
Road	7.2	9.5
Water and Public Work	5.3	2.8
Mineral Resources and Energy	1.4	1.2
Millennium Challenge Account	3.2	5.8
Agriculture and Rural Development	10.6	11.1
Governance, Security and Justice System	6.9	7.9
Other Priority Sector	1.7	2.5
Total	59.9	66.7

Source: GOM, Fundamentação OE 2012, 2012

H.3.2 Organizations Responsible for Transport Sector Funding

In the transport sector, the Directory of Economy and Investment in the Ministry of Transport and Communication is responsible for the budgeting and financing of investments in the transport system. Table H.6 describes the organizations responsible for transport sector funding. Under the Ministry, Transport and Communication Development Fund (*Fundo de Transporte e Comunicação*: FTC) was created in September 2010 in order to guarantee a balanced and sustainable management of financial resources and facilitate an integrated development of transport and communication system. FTC is to promote a public-private partnership for the development of transport infrastructure. The resources of FTC mainly derive from fuel tax. With regards to urban transport, FTC signed an agreement with FEMATRO (*Federação Moçambicana das Associações dos Transportadores Rodoviários,* association of private road transporters) in 2010 for the acquisition of 50 vehicles with capacity of 55 passengers, for leasing out the purchased buses to passenger transport operators associated to FEMATRO. In addition, FTC purchased 150 gas-powered buses from the Indian Company Tata for the use of TPM.

Table H.6: Institutions/Organizations Related to Transport Public Financing

Ministry/ Municipalities	Institutions	Major Roles
Ministry of Public Work and Housing	National Road Administration (ANE)	Executing agency for the development and maintenance of all classified roads in Mozambique.
	Road Fund	Collect the funds necessary for the development of roads and allocate the budget for road development.
Ministry of Transport and Communication	Directory of Economy and Investment	Elaborate the budget for investments in the transport sector and monitor the progress of investment projects in the sector.
	National Institute of Territorial Transport (INTTER)	Responsible for vehicle registration and driving license, and transport safety. Collecting the driving license tax.
	Transport and Communication Development Fund (FTC)	Public institution created in September 2010, in charge of the promotion of public-private partnerships for the development of transport and logistic infrastructure.

Ministry/ Municipalities	Institutions	Major Roles
	Mozambique Port and Railway (CFM)	Public enterprise responsible for the management and operation of railways and ports in Mozambique, including passenger services from Maputo to Ressano Garcia, Swaziland, and Zimbabwe.
Ministry of Finance	National Directory of Treasury	Responsible for the management of fuel tax, allocation of subsidies to public enterprises such as TPM.
	National Directory of Budget	Responsible for the elaboration of budgets for central and local government including municipalities and district administration.
Maputo Municipality	Municipal Directory of Transport and Transit	Responsible for the management of the transport system in Maputo, including the collection of vehicle parking tax, transport tax.
	Municipal Directory of Infrastructure	Responsible for the planning and financing of infrastructure investments.
	Directory of Finance	Responsible for the elaboration and allocation of budget.
	Maputo Public Transport Company (former TPM)	Public transport enterprise operating in Maputo, transferred 65% of its assets from the former TPM in 2011. Provide public transport services as well as receiving subsidies from the central government.
Matola Municipality	Municipal Directory of Transport and Transit	Responsible for the management of the transport system in Matola.
	Matola Public Transport Company (former TPM)	Public transport enterprises operating in Matola, transferred 35% of its assets from the former TPM in 2011.

Source: JICA Project Team

In the road sector, the Road Fund is responsible for collecting and allocating the funds necessary for the construction and maintenance of roads in Mozambique. Table H.7 shows the revenue that Road Fund collected between 2005 and 2009. The external resources were the major financial resources in the road sector in 2009 (44%), followed by fuel tax (30%) and tax revenue (21%).

Table H.7: Revenue of Road Fund between 2005 and 2009

Unit: MT million

	2005	2006	2007	2008	2009
Tax Revenue	630.90	826.00	1,156.00	1,482.00	1,189.00
Fuel Tax	1,193.00	1,187.40	1,334.00	1,493.00	1,749.00
Road Tax	169.20	199.20	214.80	211.00	252.00
Toll Bridge	5.12	5.70	7.40	32.00	40.00
Others	4.60	26.10	76.50	4.90	1.81
External Resources	663.00	4,037.00	2,309.40	1,867.00	2,556.00
Total	2,665.82	6,281.40	5,098.10	5,089.90	5,787.81

Source: Road Fund

A public bus company, TPM, was handed over from Ministry of Transport and Communication to Maputo and Matola Municipalities in October 2011 as part of government's decentralization policy. Maputo Public Transport Company inherited the TPM head office, 65% of TPM's buses and workers while the remaining 35% went to Matola Company. A Commercial Action Plan of TPM for 2012 states the following targets:

- Maximize the sale of pass and pre-paid ticket to MT 1,364,410;
- Increase the revenue from leasing a special transport service to private and public institutions; and
- Increase bus advertisement services from 64 buses to 248 buses.

The company adopted a strategy to increase the level of revenue through the following actions:

- Revision of tariff policy: increase MT 1.5 in the first year of 2012, rising to MT 6.5;
- Realization of the investment, which includes the renovation of vehicles;
- Introduction of the automated working process to reduce human intervention;
- Negotiate credits for the provision of services, materials, and accessories to guarantee the normal operation of company;
- Assure greater austerity in services control;
- Minimize the cost of research; and
- Ensure the equilibrium in treasury.

Table H.8 demonstrates the revenue of TPM in 2011 and 2012 (both Maputo and Matola Companies). The bus fare is planned to be increased by MT 1.5 (30% increase) in the first year of 2012, which will result in the increase of ticket sale from MT 158 million in 2011 to MT 418 million in 2012. The increase of ticket sales is also due to the increase of the number of operational buses from 196 in 2011 to 318 in 2012. The revenue from leasing bus service to public and private institutions is planned to be increased significantly from MT 55 million in 2011 to MT 223 million in 2012. The revenue from advertisement in buses is also expected to increase from MT 3 million to MT 35 million. Table H.9 shows the evolution of subsidy for TPM between 2005 and 2011. This table indicates the increasing burden of the central government to compensate the loss of financial balance in TPM.

Table H.8: Revenue of TPM in 2011 and 2012

Unit: MT

	Plan 2011	Real 2011	Plan 2012
Revenue			
Ticket Sale	87,051,013	158,428,556	418,224,300
Pass Sale	184,560	582,137	742,555
Leasing Bus (Reserved)	24,608,060	55,415,746	223,353,688
Pre-Paid Ticket	92,280	380,000	621,855
Publicity in Bus	2,768,407	2,922,081	35,034,457
Other Revenue	1,230,403	1,555,784	1,830
Total	115,934,723	140,544,906	643,294,572
Transfer from State	141,000,000	131,340,000	282,000,000
Grand total	256,934,723	271,884,906	925,294,572

Source: TPM, Plano de Actividades Para 2012, 2011

Table H.9: Budget of the Transport Sector in State Budget between 2005 and 2011

Unit: MT thousand

	2005	2006	2007	2008	2009	2010	2011
Subsidy to TPM	30,446.0	48,428.5	54,820.9	69,497.7	94,564.4	108,748.9	132,131.4
Other Expense of Transport*				29,400.0			97,935.9

Source: Data from Ministry of Finance

* The amount stated related to subsidy to private passenger carriers (chapas), in the context of compensating the difference of gasoline price to maintain transport price

The expenditure of TPM in 2011 and 2012 (both the Maputo and Matola companies) is shown in Table H.10. With the introduction of 150 gas-powered buses in 2011, the payment of diesel will be reduced significantly by its percentage share, from 64% of the total direct cost in 2011 to 27% in 2012. The cost of gas fuel will increase by 28%, but the percentage of total fuel cost will decline from 64% to 54%, which is significant considering the rising cost of fuels recently (See Section 2.4). The current price of diesel stands at 38 MT/litre, while that of gas costs 18 MT/litre. There is one gas station in Matola, which has been operated by the Gas Company and imported from South Africa. There is a plan to process and refine gas in Mozambique, but technical deficiency is a major constraint to materialize the refining process (interview with Maputo Municipal Council).

Nevertheless, the purchase of gas-powered buses placed a substantial burden on the financial balance in TPM. Despite the planned increase of bus fare by MT 1.5, there will be a huge deficit in the financial balance of TPM in 2012. Financial sustainability of TPM, while ensuring a public transport service to all strata of citizens, is a crucial issue in the transport sector in Maputo and Matola. The same financial difficulty has been stated in private passenger buses (*chapa*), and many *chapas* have a deficiency of maintenance and equipment due to the decreasing income mainly caused by the current lower level of tariff.

Table H.10: Payment of TPM in 2011 and 2012

Unit: MT

	Plan 2011	Real 2011	Plan 2012
1. Direct Payment			
Spare parts	9,228,023	16,827,420	20,282,686
Consumption of Diesel	48,477,879	55,978,440	119,360,260
Consumption of Normal Gas	0	0	123,958,288
% of Diesel Cost in Direct Cost	67%	64%	27%
% of Normal Gas in Direct Cost	0%	0%	28%
Oil and lubricant	2,460,806	2,325,971	16,034,619
Tyres and belts	9,166,508	10,024,868	67,800,000
Tickets	2,460,806	2,471,805	5,436,916
Recovery of bus	0	0	90,000,000
Others	615,202	421,903	824,363
Total	72,409,225	88,050,408	443,697,133
2. Indirect Payment	86,489,068	141,571,678	272,368,618
3. Tax Payment	7,772,651	2,263,808	28,118,907
4. Payment to bank			206,970,000
5. Other Payment	19,684,316	18,340,365	82,871,171
6. Investment			
Equipment of transport	0	538,266,000	336,000,000
Equipment for workshop	0	0	17,340,000
Equipment and furniture in office	922,802	65,179	35,739,146
Communication	0	0	1,680,000
Equipment for Driving School	0	0	2,891,987
Equipment for Information and software	0	0	3,640,000
Work	492,161	1,975,890	60,792,370
Others	0	0	22,526,070
Total	1,414,963	540,307,069	480,609,573
Grand Total	187,770,223	790,533,328	1,514,635,402

Source: TPM, Plano de Actividades Para 2012, 2011

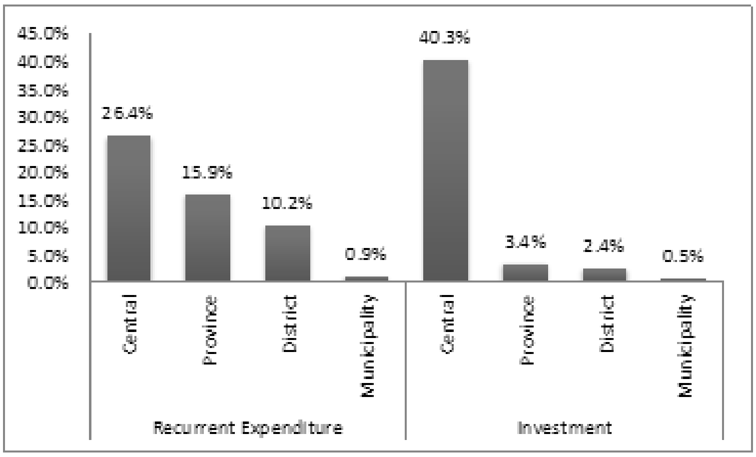
H.4 Public Financing in Municipalities and Districts

H.4.1 Decentralization of Public Finance

The Law 2/97 created 33 municipalities with the financial autonomy of collecting the revenue and allocating the budget. The financial autonomy of municipalities was further extended by the Law 1/2008, which enabled municipalities to collect property and vehicle taxes. The number of municipalities also increased to 43 in 2008. There are two types of transfers from the central government to the municipalities, which are managed by municipalities autonomously;

1) Municipal Compensation Fund (*Fundo de Compensação Autárquica*: FCA) to cover the recurrent expenditure; and
2) Municipal Initiative Fund (*Fundo de Iniciativa Autárquica*: FIA) to cover the investment cost.

The Law 1/2008 determines the allocation of FCA and FIA as 1.5% of the total State Revenue every year. In addition to municipalities, the state budget is allocated to 11 provinces and 128 districts, or so-called local state organs. The budget of local state organs are prepared by district government, and then submitted to the Ministry of Finance for consideration and approval. Figure H.1 shows the structure of state budget allocated to provinces, districts, and municipalities in 2012. The percentage of budget allocated to municipalities is very low (1.5%) compared to province (19.3%) and districts (12.6%). The decentralization of state fund to local state organs is clearly demonstrated in the allocation of internal resources, in which central government accounts for 26.4% of the total expenditure while around 27% is allocated to provinces, districts and municipalities. Hence, the financial decentralization in terms of tax allocated to local governments in Mozambique is larger compared to other African countries such as Kenya (5% of national income tax) Ghana (not less than 5% of total central government revenue), but still lower compared to Japan (32% of National Income Tax and Corporation Tax, and 29.5% of IVA).



Source: GOM, Fundamentação OE 2012, 2012
Note: Recurrent Expenditure to Municipality means FCA, and Investment expenditure to Municipality means FIA.

Figure H.1: Allocation of State Budget by Region in 2012

The distribution of FCA and FIA is determined by the number of habitants and territorial area by the Law 1/2008. Accordingly, the larger municipalities such as Maputo received the greater amount of FCA and FIA. In addition to FCA and FIA, Road Fund allocates a budget for the investment and maintenance of roads to municipalities. The financial autonomy of municipalities in public infrastructure investments including the roads was provided by the Law

1/2008. Table H.11 shows the evolution of state transfer to Maputo and Matola municipalities and Marracuene and Boane between 2005 and 2011. The investment budget transferred from the central government includes: 1) FIA; and 2) Road Fund. FIA in Maputo increased by 336% from MT 25.5 million in 2005 to MT 85.7 million in 2011, while Matola received MT 57.2 million of investment fund (FIA) in 2011. The fund for the management and maintenance of roads was transferred to municipalities from 2008, accounting for MT 15.23 million for Maputo municipality and MT 12.2 million for Matola in 2011. The Medium Term Fiscal Frameworks in Maputo 2010–2012 and 2013–2015 were not available at the time of writing[7].

Marracuene and Boane have received the District Development Fund (FDD) from the central government since 2006. FDD is the investment budget to create jobs or boost food production with the initiative of district administration. Marracuene and Boane received MT 14.9 million and 15.4 million of FDD in 2011 respectively (Table H.11). There is no transfer from Road Fund to districts to maintain the roads within the jurisdiction of districts; that is, ANE has implemented the construction and maintenance of all classified roads in districts.

Table H.11: State Transfer to the Project Area between 2005 and 2011

Unit: MT million

Municipals	2005	2006	2007	2008	2009	2010	2011*
Maputo City	76.3	97.1	97.8	161.5	154.2	260	295.1
Municipal Compensation Fund (FCA)	50.8	60.6	64.5	107.9	107.9	137.2	193.6
Municipal Initiative Fund (FIA)	25.5	36.6	33.3	37.4	39.7	50.5	85.7
Road Fund				16.2	6.6	72.3	15.8
Matola City	33.9	39.9	47.1	84	82.8	100.7	163.6
Municipal Compensation Fund (FCA)	21.1	25.1	28.9	47	52.5	66.7	94.2
Municipal Initiative Fund (FIA)	12.8	14.8	18.2	20.5	23.3	29.7	57.2
Road Fund				16.5	7	4.3	12.2
Marracuene District	9	15.4	17.1	27.1	97.5	161	137.6
Operation	9	8.4	9.5	17.1	86.9	148.5	122.7
Ordinary Revenue	5.1	6.9	8.1	15.8	86.5	116.1	
Consigned Revenue	0	0	0	0	0	30.2	
Own Revenue	3.9	1.5	1.3	1.4	0.4	2.2	
Investment		7	7.7	10	10.6	12.5	14.9
Boane City	7.7	14.1	16.3	29.6	139.2	198.9	261.3
Operation	7.7	7.1	8.3	19.2	128.2	186.5	245.9
Ordinary Revenue	5.6	5.4	6.9	18.1	126.7	184.7	
Consigned Revenue	0	0	0	0	0.1	0	
Own Revenue	2	1.6	1.4	1.1	1.4	1.8	
Investment		7	8	10.3	11	12.4	15.4

Source: Data from Ministry of Finance
* indicates the State Budget under review.

Table H.12 shows the proposed budget in Maputo in 2008 and 2009. FIA covers only 4% to 8% of the total revenue in Maputo in 2008 and 2009. The majority of investment resources were financed by other state transfer and external resources (57% of the total). The revenue from external resources such as the World Bank and the state transfer specialized for the road rehabilitation accounts for 158 million and MT 77 million respectively in 2011. The large infrastructure investments in Maputo were, therefore, financed by external resources including the special state transfer. The transfer from Road Fund fluctuates from nil to MT 76.32 million in Maputo municipalities, and more stable resource provision to municipalities will be desirable for better financial planning of road maintenance.

[7] The Medium term Fiscal Framework in Maputo 2010–2012 and 2013–2015 are expected to be approved by June 2012.

Meanwhile, Maputo Municipality has collected vehicle tax, parking tax, and urban transport tax (tax to *chapa*). The vehicle tax is classified as fiscal revenue, which was introduced by the Law 1/2008. Unlike other taxes such as property tax, the vehicle tax is fixed by vehicle type: for instance, a new vehicle with capacity of 1,000 cc to 1,300 cc is required to pay MT 400 annually. The vehicle tax was estimated at MT 38 million in 2011.

Table H.12: Proposed Budget in Maputo Municipality in 2008 and 2009

Unit: MT thousand

	2,008	**Percent Structure**	**2,009**	**Percent Structure**
Revenue	458,217	100	1,042,959	100
1. Current Revenue	337,723		412,292	
1.1 Fiscal Revenue	84,860	19	111,505	11
1.2 Non-Fiscal Revenue	88,340	19	115,362	11
1.3 Consigned Revenue	56,666	12	77,568	7
1.4 Current Transfer	107,857		107,857	
1.4.1 Municipal Compensation Fund (FCA)	107,857	24	107,857	10
2. Capital Revenue	120,494		630,667	
2.1 Revenue from Goods	500	0	800	0
2.2 Revenue from Service	800	0	500	0
2.3 Other Capital Revenue	81,000	18		
2.4 Capital Transfer	38,194		629,367	
2.4.1 Municipal Initiative Investment Fund (FIA)	37,422	8	39,737	4
2.4.2 Others	772	0	589,630	57
Expense	458,217	100	1,042,959	100
1. Employee Expense	279,350		308,639	
1.1 Personnel Expense	157,741	34	187,409	18
1.2 Goods and Services	56,686	12	71,313	7
1.4 Current Transfer	550	0	3,134	0
1.6 Other Current Expense	64,374	14	46,783	4
2. Capital Expense	178,867		734,320	
2.1 Construction	93,376	20	257,805	25
2.2 Machine and Equipment	84,719	18	55,093	5
2.3 Other Capital Expense	772	0	421,422	40

Source: GOM, Orçamento do Estado para 2009, 2008

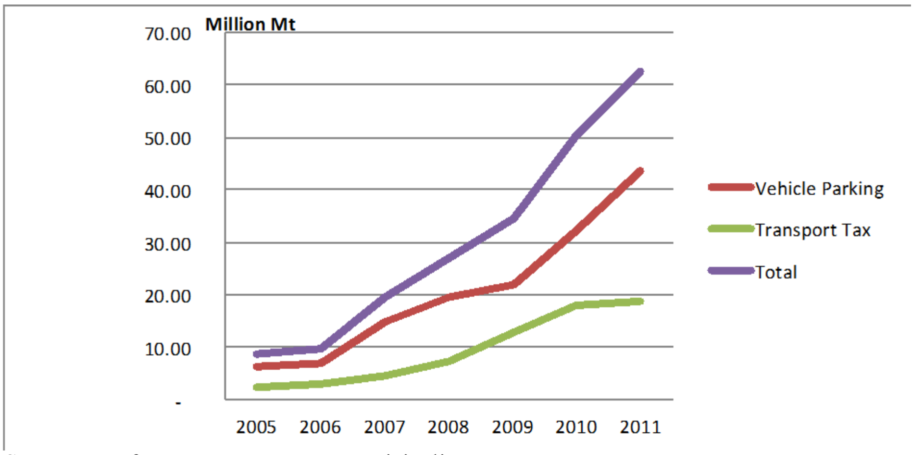
The vehicle parking tax and urban transport tax (tax to private bus, *chapas*) are classified as non-fiscal revenue, and Municipal Directory of Transport and Transit (DMTT) collects and manages the revenue directly. The revenue collected by DMTT, however, goes to the Municipal account that is managed by Directory of Finance, and then Directory of Finance allocates these revenues to the investment of the transport sector. Table H.13 demonstrates the revenue and investment executed by DMTT between 2005 and 2011. The total revenue from vehicle parking and urban transport tax accounts for 62.53 million in 2011, but the investment allocated for the traffic signal system was MT 25.59 million, signifying MT 36.94 million lower than the revenue. Nonetheless, the revenue from vehicle parking tax and urban transport tax increased significantly from 2005 to 2011, as shown in Figure H.2. It is suggested that the investment cost for traffic control can be covered by non-fiscal transport revenue, and there is the possibility to finance part of the investment cost for public transport infrastructure, provided that vehicle parking tax will continue to expand as recently.

Table H.13: Revenue and Investment in Maputo Municipality in the Transport Sector between 2005 and 2011

Unit: MT million

	2005	2006	2007	2008	2009	2010	2011
Non-Fiscal Revenue							
Vehicle Parking	6.31	6.84	14.96	19.71	21.93	32.07	43.77
Transport Tax	2.40	2.95	4.49	7.46	12.72	18.15	18.76
Total	**8.71**	**9.79**	**19.45**	**27.17**	**34.65**	**50.22**	**62.53**
Investment Expense							
Signal Expense (Traffic Expense)		6.86	11.26	15.56	5.60	6.55	25.59

Source: Data from DMTT, Maputo Municipality



Source Data from DMTT, Maputo Municipality

Figure H.2: Evolution of Vehicle Parking Tax and Urban Transport Tax in Maputo between 2005 and 2011

In Matola, the percentage of FIA in Matola is larger than Maputo, comprising 16%–18% of the total revenue in 2008 and 2009 (Table H.14). The amount and percentage structure of investment resource are also smaller in Matola; MT 49.6 million or 34% of resources were spent for the whole investment in 2009. The maintenance of roads was mainly financed by a transfer from the Road Fund, which accounts for around MT 8.5 million between 2008 and 2012 on average (Table H.12).

Table H.14: Proposed Budget in Matola Municipality in 2008 and 2009

Unit: MT thousand

	2,008	Percent Structure	2,009	Percent Structure
Revenue	114,471	100	148,679	100
1. Current Revenue	93,974		125,347	
1.1 Fiscal Revenue	13,000	11	12,870	9
1.2 Non-Fiscal Revenue	33,951	30	55,598	37
1.3 Consigned Revenue			4,400	3
1.4 Current Transfer	47,024		52,478	
1.4.1 Municipal Compensation Fund (FCA)	47,024	41	52,478	35
2. Capital Revenue	20,497		23,332	
2.1 Revenue from Goods				
2.2 Revenue from Service				
2.3 Other Capital Revenue				
2.4 Capital Transfer	20,497		23,332	
2.4.1 Municipal Initiative Investment Fund (FIA)	20,497	18	23,332	16
Expense	114,470	100	148,679	100
1. Employee Expense	77,552		99,047	
1.1 Personnel Expense	41,420	36	49,457	33
1.2 Goods and Services	33,345	29	37,531	25
1.4 Current Transfer				
1.6 Other Current Expense	2,797	2	12,059	8
2. Capital Expense	36,918		49,632	
2.1 Construction	24,800	22	28,032	19
2.2 Machine and Equipment	12,118	11	12,700	9
2.3 Other Capital Expense			8,900	6

Source: GOM, Orçamento do Estado para 2009, 2008

H.5 Major Findings

The above sections provide the following suggestions for the sustainable public financing in the transport/road sector:

Financing Sources of Transport

- **Reduce the dependence on external resources, and review the distribution and the budget planning of FIA**: The transport/road sector relies heavily on external resources for the investment of infrastructure. Maputo Municipality received both external resources and a transfer from Road Fund to finance the construction and maintenance of roads, while Matola Municipality solely depends on resources from Road Fund. Since the role of transferred resources from Road Fund to maintain the road is large, more stable provision of the transfer from Road Fund is essential for better financial planning and road maintenance. In addition, to reduce the dependence on external resources for infrastructure financing, the percentage share of FIA in the total state budget needs to be reviewed carefully. The distribution of FIA also needs to be specified, like in the MTFF, by identifying priority sectors.

  Pursuing private sector involvement through Public Private Partnerships (PPP) and Transit Oriented Development (TOD) would also reduce the reliance on external resources and central government transfers. While PPP and TOD arrangements can be difficult to achieve because of the private sector's return requirements, private sector investment in Greater Maputo's transportation system represents a true extension of financing capacity from the current tax and fee based sources and external financing from development agencies.

Public Transport Tariff

- **Review public transport tariffs with consideration of financial sustainability and public transport services accessible to all**: Despite the efforts described in the Commercial Action Plan of TPM, there remains a huge deficit in the financial balance of TPM. The tariff in public transport system needs to be reviewed in order to improve the financial sustainability of TPM, while ensuring a public transport service to all strata of citizens.

Cost Reduction in Transport Financing

- **Integrated transport and energy strategy and public-private transport infrastructure financing can be sought after to solve the financial crisis in public transport**: In addition to a tariff, further efforts will be required to reduce the direct cost of TPM by the conversion of fuel from diesel to gas. Hence, an integrated transport and energy strategy will be required to solve the financial crisis in public transport. The newly created FTC has the potential to provide more gas-powered vehicles, not only for TPM but also for private passenger buses through FEMATRO, and to facilitate public-private transport infrastructure financing in future.

Capacity and Institutional Development in Decentralization

- **Capacity development needs to be emphasized, considering the context of financial decentralization**: The recent rapid financial decentralization needs to be undertaken along with capacity development and institutional development of municipalities to handle the transferred public finance from the central government efficiently and transparently.

Technical Report I

Institutional and Capacity Development Issues in the Urban Transport Development Process

Contents

Figures

Tables

Technical Report I Institutional and Capacity Development Issues in the Urban Transport Development Process

I.1 Introduction

There are several major urban development projects being prepared by various government agencies in Greater Maputo, but the planning and implementation process of these projects is not currently well coordinated among relevant government organizations. Some are proposed by foreign investors, but many of the government agencies do not have adequate capacity to examine the viabilities of those projects. It is important to examine institutions and capacity of key organizations to ensure sustainability of urban transport policies and practices.

Section I2 provides an overview of the administrative system in Mozambique. The sections that follow describe functional responsibilities of transport and traffic organizations and their policy coordination issues. Preliminary analysis on capacity assessment of key institutions, and higher education institutions are also presented together with summary of findings and workshops and training activities.

I.2 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; and
- Establishment of an Institute for Transport and Traffic Studies.

I.3 Greater Maputo Metropolitan Transport Agency (GMMTA)

I.3.1 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:

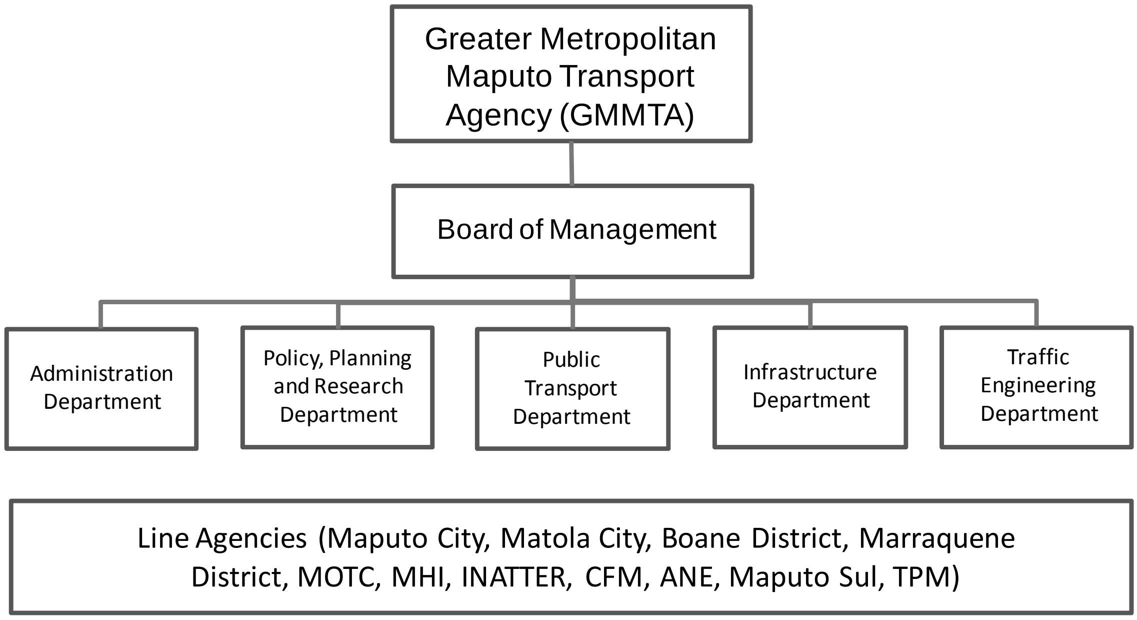
- prepare a transport master plan for the Greater Maputo Metropolitan Area (ongoing with the assistance of JICA);
- update the transport master plan periodically in tune with changes in the traffic and transport environment in the region;
- coordinate and monitor the implementation of the transport master 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; and
- 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) ; and
- Maputo Sul.

A tentative organizational structure of the agency is shown in Figure I.1.



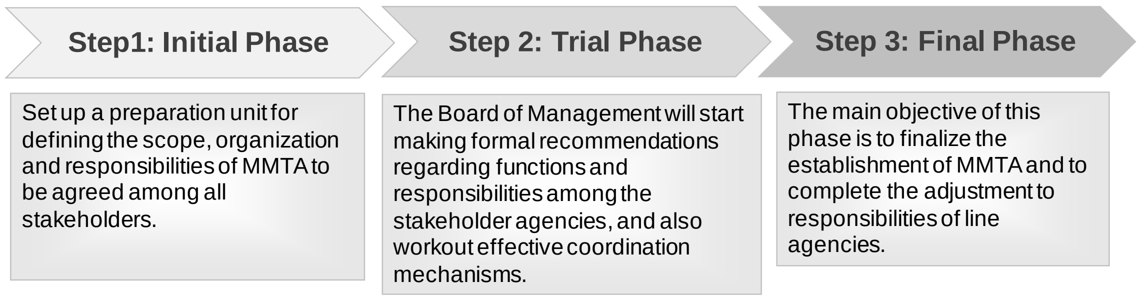
Abbreviations: ANE = National Roads Administration (Administração Nacional de Estradas), CFM = Mozambique Ports and Railways (Portos e Caminhos de Ferro de Moçambique), MHI = Ministry of Housing and Infrastructure, MOTC = Ministry of Transport and Communications, TPM = Transportes Publicos de Maputo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

Source: JICA Project Team

Figure I.1: Tentative Organizational Structure of GMMTA and Its Relationship with Line Agencies

I.3.2 Suggested Process for Establishing the GMMTA

The proposed GMMTA can be established in three steps as shown in Figure I.2. The above-mentioned objectives, functions, responsibilities of the agency will be revised or elaborated in three phases.



Source: JICA Project Team

Figure I.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; and
7. Submission of recommendations to the Board of Management on any decisions and/or actions regarding the above matters.

A limited number of personnel is required at this stage as shown in Table I.1.

Table I.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 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; and
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 I.2 estimates personnel requirements for the Trial Phase.

Table I.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; and
3. Allocation of the required resources to make the GMMTA fully operational.

Table I.3 shows the tentative personnel requirement for the Final Phase.

Table I.3: Tentative Personnel Requirement for the Final Phase

Subunit	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
Infrastructure Department	5–6	Representatives from DMI Maputo, DMI Matola, Boane City, Marracuene Districts, 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. The department will be responsible for providing basic user information such as route maps, fares, and the latest operating schedules of all regulated services. 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 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; and
- code and guidelines for roads and intelligent transport system (ITS) facilities.

I.3.3 Capacity Building Project for the Establishing the GMMTA

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

I.3.4 Example Structure for the Public Transport Department, GMMTA

The Public Transport Department will be responsible for planning and managing all public transport services operating within the Greater Maputo area. These will include services operated by bus, taxi, water, metro or light rail services, and other modes if applicable. The Department will absorb some existing departments and agencies within local government.

The principal functions and responsibilities of the Department will be:

- Public transport route and service planning (all modes)
- Procuring and controlling the supply of public transport (all modes including informal)
- Setting and enforcing quality standards
- Regulation of public transport fares and other transport charges
- Management of public transport infrastructure
- Implementation of public transport priority measures
- Promoting public transport use
- Provision for pedestrians and non-motorised transport

In the short term, the Department will also be responsible for facilitating implementation of the public transport recommendations of the Transport Master Plan, including setting up and introducing the proposed bus service licensing processes, and the formalisation of the bus and chapa industry. Subsequently, the Department will be responsible for continuing implementation of the system.

It is also important that the interests of pedestrians and cyclists are catered for. Since all public transport journeys (and most private transport journeys) include a pedestrian component, it is appropriate for the Public Transport Department to take on this role. The requirements of pedestrians and cyclists have much in common, and it is therefore also logical to group all non-motorised passenger transport under a single function.

Performance of some of the Department's functions could be delegated to private sector agencies but would be supervised by the authority. Initially, however, all functions should be retained within the Department in order to facilitate control while the requisite expertise is being developed.

A key requirement is the appointment of suitably qualified and experienced personnel to carry out the various tasks: some officers in existing agencies whose functions are to be transferred to the authority should themselves be transferred, but in many cases it may be necessary to arrange training to enhance their capabilities. For some posts it may be necessary to recruit new staff: again, suitable training should be arranged. It is also important to take all possible steps to ensure that staff, once trained, are retained, and are not tempted to accept positions in organisations outside the transport sector which offer better conditions.

Finding the right people will take time, and the temptation to appoint unsuitable people who are immediately available must be avoided. During the initial stages, therefore, it is unlikely that all posts can be filled; in addition, at this stage there will be a number of "one-off" tasks which will require temporary additional assistance. To fill the gap before permanent staff can be appointed, it will therefore be necessary to fill a number of posts on a short-term basis. This will include the engagement of external consultants, mostly if not all from overseas, for at least the first two years, to carry out specific tasks and at the same time to provide essential on-the-job-training.

It is recommended that an external public transport adviser should be appointed to assist in the creation of the department and during the start-up phase. The adviser should have specialist expertise in public transport and should also have the relevant experience to be able to assist in the setting up of a new department. His role will be to ensure that the department is appropriately structured and staffed, and to assist the staff in performing their various tasks during the authority's first year of operation and, if necessary, for a second year. This will provide valuable on-job training and capacity building in addition to ensuring that key tasks are properly carried out during a critical time.

The Department will be sub-divided into functional sections; the main functions of the various sections are listed below, together with the staff required for each. Staff numbers are estimates of those required on setting up of the Authority; as the Authority's role expands, the numbers in some areas will increase, as will the number of different functions.

(1) Sections within the Department:

- Planning
- Licensing
- Monitoring and Enforcement

Planning

Functions

- Input to planning of public transport network (assisting external consultants)
- Specifying service capacities and schedules
- Continuous updating of network and schedules

- Advising on revenue control systems
- Liaising with urban planning authorities and developers, and reviewing and providing input to new development plans
- Ensuring compatibility of public transport plans with other central and local government plans
- Monitoring innovations in public transport technology

Staff (9)

- Transport Planner – head of department (1)
- Public Transport Specialist (1) (Later, it may be necessary to split this role, and employ separate modal specialists in bus, taxi, rail, water and other relevant fields)
- Schedules and Timetables Specialist (1)
- Transport Economist (1)
- ITS/Telematics Specialist (1)
- NMT Specialist (1)
- Planning Assistant (2)
- Secretary (1)

Licensing

Functions

- Managing bidding process for public transport service licenses (all formal modes)
- Inviting bids
- Assessing bids
- Selecting short list
- Negotiating with bidders
- Selecting and negotiating with preferred bidders
- Issuing new route licenses and dealing with license renewals
- Dealing with license infringements
- Allocation of fare revenue (and subsidies if applicable) to licensed bus operators

Staff (8)

- Licensing Manager (1)
- License Officer (bid assessment/negotiation) (3)
- License Clerk (3)
- Secretary (1)

Monitoring and Enforcement

Functions

- Collecting operating statistics from transport operators
- Conducting or commissioning surveys as required
- Checking operator performance using key performance indicators and other tools
- Checking condition of terminals and bus stops
- Developing/analysing KPIs and identifying trends/problems
- Identifying sub-standard performance
- Initiating and following up enforcement processes
- Analysing costs and revenues and advising on fare structures and levels
- Compiling periodic reports as required

Staff (18)

- Quality Manager (1)
- Public Transport Analyst (1)
- Statistics Officer (2)
- Survey Officer (3)
- Inspector (10)
- Secretary (1)

Administrative Assistant

Functions

- General office management functions for the Public Transport Department
- Supervise section support services and staff
- Setting up and maintaining public transport database and public transport library
- Production of maps and other graphics
- Facilitate internal and external communication
- Arrange meetings and meeting rooms
- Liaise with GMMTA HR department in administration of recruitment of Public Transport Department staff
- Assist in identifying relevant conferences, exhibitions, courses etc
- Maintain office stationery supplies
- Arrange transport for inspectors etc on official duties

Staff

- Database Specialist (1)
- Draughtsman (1)
- Clerical Assistant (1)
- Drivers (2)

(2) Key Personnel: Responsibilities, Functions, and Required Qualifications and Experience

Director - Public Transport Division

Responsibilities and Functions

- Ensuring the delivery of an adequate, efficient and cost-effective public transport system for Greater Maputo
- Management of the Public Transport Division
- Liaison with managers of other Divisions within the GMMTA
- Liaison with other Government departments
- Advising and recommending on public transport fares and charges

Qualifications and Experience

- An understanding of public transport characteristics and requirements
- Proven organisational skills
- Ability to identify, understand and prioritise key issues
- Experience in working with senior officials in government and private sector
- University degree in a relevant discipline

Public Transport Adviser (temporary: international consultant)

Responsibilities and Functions

- Advising on public transport service operational matters
- Facilitate implementation of public transport projects
- Assisting in developing regulations for public transport services
- Identifying potential developments in all public transport modes
- Working with the Public Transport Planner in developing integrated route networks
- Identifying appropriate vehicle specifications and technologies for each category of services
- Assisting in developing fare structures
- Advice on revenue control systems
- Working with other modal specialists (when applicable) to ensure integration of all public transport modes

Qualifications and Experience

- Advisory or consultancy experience in regulatory, institutional and operational aspects of public transport
- Management of public transport operations in developed and developing countries
- Planning public transport services
- University degree in a relevant discipline
- Internationally recognised professional qualification in transport

Public Transport Planning Manager

Responsibilities and Functions

- Managing the Planning Section
- Input to planning an integrated public transport network for Greater Maputo
- Developing detailed route network plans and schedules
- Liaising with urban planning authorities and developers
- Instigate/conduct feasibility studies as required

Qualifications and Experience

- Planning of public transport networks
- Working experience with a large public transport operator or regulator
- Skilled in the use of relevant graphic software

Public Transport Licensing Manager

Responsibilities and Functions

- Managing the Licensing Section
- Managing bidding process for public transport service licenses (all formal modes)
- Selecting and negotiating with preferred bidders
- Overseeing the administration of the route licensing system

Qualifications and Experience

- Working experience in a similar position
- A good understanding of public transport characteristics and requirements
- Good administrative ability
- University degree in a relevant discipline

Public Transport Quality Manager

Responsibilities and Functions

- Managing the Monitoring Section
- Monitoring performance of public transport operators in Greater Maputo
- Overseeing data analysis processes
- Analysing public transport trends and developments worldwide

Qualifications and Experience

- Working experience in a similar position
- A good understanding of public transport characteristics and requirements
- Numerate and computer literate
- Good administrative ability
- University degree in a relevant discipline

Public Transport Support Manager

Responsibilities and Functions

- Managing the Support Services Section
- Setting up and maintaining public transport database and public transport library
- Organising transport for section personnel

Qualifications and Experience

- Working experience in a similar position
- Good administrative ability
- University degree in a relevant discipline

Administrative Assistant

Responsibilities and Functions

- General office management and secretarial functions for the Public Transport Department
- Supervising support staff

Qualifications and Experience

- Working experience in a similar position
- Computer literate

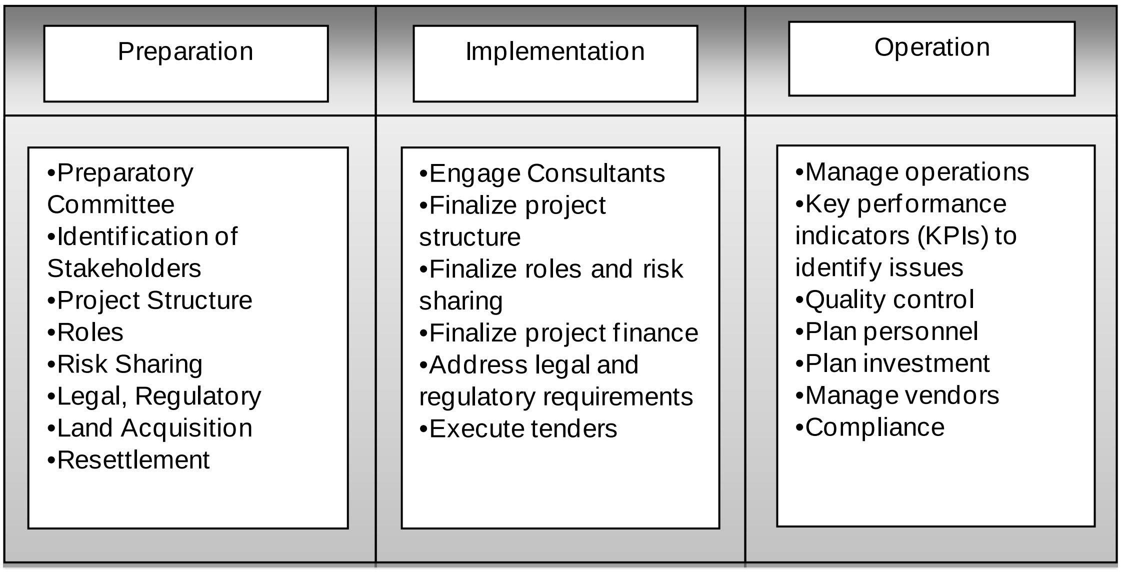
Vehicle Requirements

The Public Transport Department will require at least two vehicles (e.g. 4wd crew-cab pick-ups) for inspection and other purposes.

I.4 Assessment of Master Plan Implementing Organizations

I.4.1 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 I.3.



Source: JICA Project Team

Figure I.3: Master Plan – Implementation Process

(1) Preparation

The preparatory committee will considers a project or 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 go proceed understanding the concerns of 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 law. 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 technical the 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 the 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 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.

I.4.2 Overall Implementation Organization

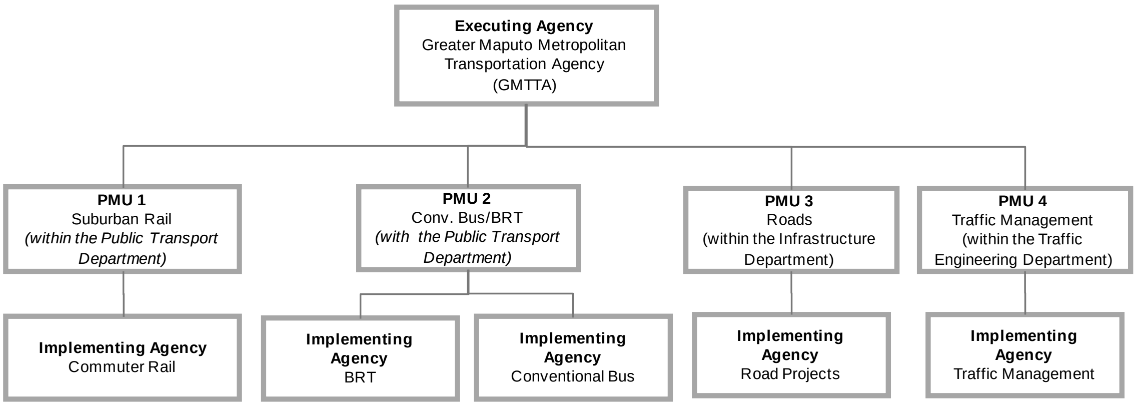
The following institutional arrangements are recommended for implementing the Master Plan projects.

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 I.4 displays a tentative implementation structure and the relationship between the respective entities:



Source: JICA Project Team

Figure I.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.

I.4.3 Project Management Units (PMUs)

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. Suggested members of each of the PMUs are listed below:

- PMU for Commuter Rail Projects:
  - a. Councilors for Maputo City Transport and Traffic Municipal Directorate
  - b. Councilors for Matola City Transport and Traffic Municipal Directorate
  - c. Representatives of Marracuene District and Boane City
  - d. Representative of INNARTEL
  - e. Representative of Caminhos de Ferro de Moçambique (CFM)
  - f. Representative of Maputo City Councilors Finance Municipal Directorate.
  - g. Representative of Maputo City Councilors Urban Planning and Environment Municipal Directorate

- PMU for Conventional Bus and BRT Projects:
  - a. Councilors for Maputo City Transport and Traffic Municipal Directorate
  - b. Councilors for Matola City Transport and Traffic Municipal Directorate
  - c. Representatives of Marracuene District and Boane City
  - d. Representative of Directorate of Municipal Transport and Traffic (DMTT Maputo, DMT Matola)

e. Representative of Directorate of Municipal Infrastructure (DMI Maputo, DMI Matola)
f. Representative of Administração Nacional de Estradas (ANE, National Roads Administration)
g. Representative of Transportes Públicos de Maputo (TPM)
h. Representative of Federação Moçambicana das Associações dos Transportadores Rodoviários (FEMATRO)
i. Representative of Maputo City Councilors Finance Municipal Directorate.
j. Representative of the Road Fund
k. Representative of Development Fund of Transport and Communications (FTC)
l. Representative of Maputo City Councilors Urban Planning and Environment Municipal Directorate

- PMU for Road Projects:

a. Councilors for Maputo City Transport and Traffic Municipal Directorate
b. Councilors for Matola City Transport and Traffic Municipal Directorate
c. Representatives of Marracuene and Boane
d. Representative of DMI Maputo, DMI Matola
e. Representative of Boane City, Marracuene District
f. Representative of ANE
g. Representative of Maputo City Councilors Finance Municipal Directorate
h. Representative of the Road Fund
i. Representative of Maputo City Councilors Urban Planning and Environment Municipal Directorate

- PMU for Traffic Management Projects:

a. Councilors for Maputo City Transport and Traffic Municipal Directorate
b. Councilors for Matola City Transport and Traffic Municipal Directorate
c. Representatives of Marracuene and Boane
d. Representative of DMTT Maputo, DMT Matola
e. Representative of DMI Maputo, DMI Matola
f. Representative of Boane City, Marracuene District
g. Representative of ANE
h. Representative of Maputo City Councilors Finance Municipal Directorate
i. Representative of the Road Fund
j. Representative of Maputo City Councilors Urban Planning and Environment Municipal Directorate

I.4.4 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 I.4 outlines the suggested IAs for each Master Plan project.

Table I.4: Suggested Implementing Agencies

Project Component	Suggested Implementing Agency/Agencies
Road Network	
➢ Maputo North/South Arterial	• DMI Maputo
➢ Ring Road and East/West Arterial	• ANE, Maputo Sul
➢ W. Matola Industrial Area Arterial	• DMI Matola
➢ National Roads, Other Arterials	• ANE
➢ District Arterials, Main Streets	• 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
Suburban Rail	
➢ 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)	
➢ 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	
➢ 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 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 Authority

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 all national road development, including planning and policy functions. ANE is recommended as the IA for two road network projects.

I.4.5 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 I.5:

Table I.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 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

I.5 Institute for Transport and Traffic Studies

I.5.1 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; and
- 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).

I.5.2 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.

I.5.3 Capacity Development Project at ISUTC/UEM

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; and
- 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 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 are only 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.

I.6 Overview of Administrative Systems in Mozambique

I.6.1 Introduction

Every city has a unique history, development experience and administrative structure. Greater Maputo is no exception. This section overviews the administrative systems in Mozambique, describes organizational structure and the functional responsibilities and the national, provincial, and district level administrations. Particular attention is paid in the administrative systems of cities and districts in relation to urban management and infrastructure development.

I.6.2 Province, Municipality, and Districts

Mozambique is divided into 11 provinces (including Maputo City), with each province divided into districts, and in turn the districts are divided into administrative posts and these into localities (*localidades*), which are the lowest level of state representation. Since 1998, an additional administrative structure was added in the form of municipality (autarchies). There are now 43 municipalities in the country, in which 23 have 'city' status and 20 are 'towns'. Out of the 43 municipalities, 14 are in the northern region, 16 in central region and the remaining 13 in the southern region.[1] One of the 23 cities is Maputo, the capital city which, unlike the remaining cities, has 'province' status.

Since 1994, the country president is elected for a five year term. The parliament, National Assembly, is composed of 250 members, elected also for a five year period. At the municipality (city and town) level, the Mayor and the Municipal Assembly are also elected. Each province is governed by a Provincial Governor who is appointed by the President of Mozambique. The position of Governor is nominated and not elected, thus it is regarded as a position of political trust. Since Maputo City has a status of province, it has a Provincial Governor as well as a Mayor.[2]

The province is the biggest economic and social organizational unit of the State's local administration. The provincial government is the body responsible for ensuring the execution of the government's policies decided at the central level.[3]

The district is composed by administrative posts and localities (*localidades*). According to Decree No. 6/2006 (12 April 2006) a district government is managed by a District Administrator, an Administrator's Office and a District Secretary. The District Administrator is in charge of education, youth and technology, health, woman and social action, planning and infrastructures, economic activities and other services (to be locally defined in coordination with the province).

I.6.3 Maputo Municipality (City)

Maputo Municipality (City), the capital of Mozambique, consists of seven districts. UD1 (*KaMpfumu*) is the oldest urbanized area and the center for business and commercial activities in Maputo. The remaining urban districts are UD2 (*M Nhlamankulu*), UD3 (*KaMaxakeni*), UD4 (*KaMavota*), UD5 (*KaMubukwane*), and Catembe (*KaTembe*) and Inhaka (*KaNyaka*). Each urban district is directed by an Administrator responsible for implementing economic, social and cultural services and programmes of local interest under the city supervision. An urban district is composed of a set of villages (*bairros*). A *bairro* is administered by a chief and secretaries who are elected by the residents. There are also community authorities (such as *régulos*) who help the community and support government authorities.[4]

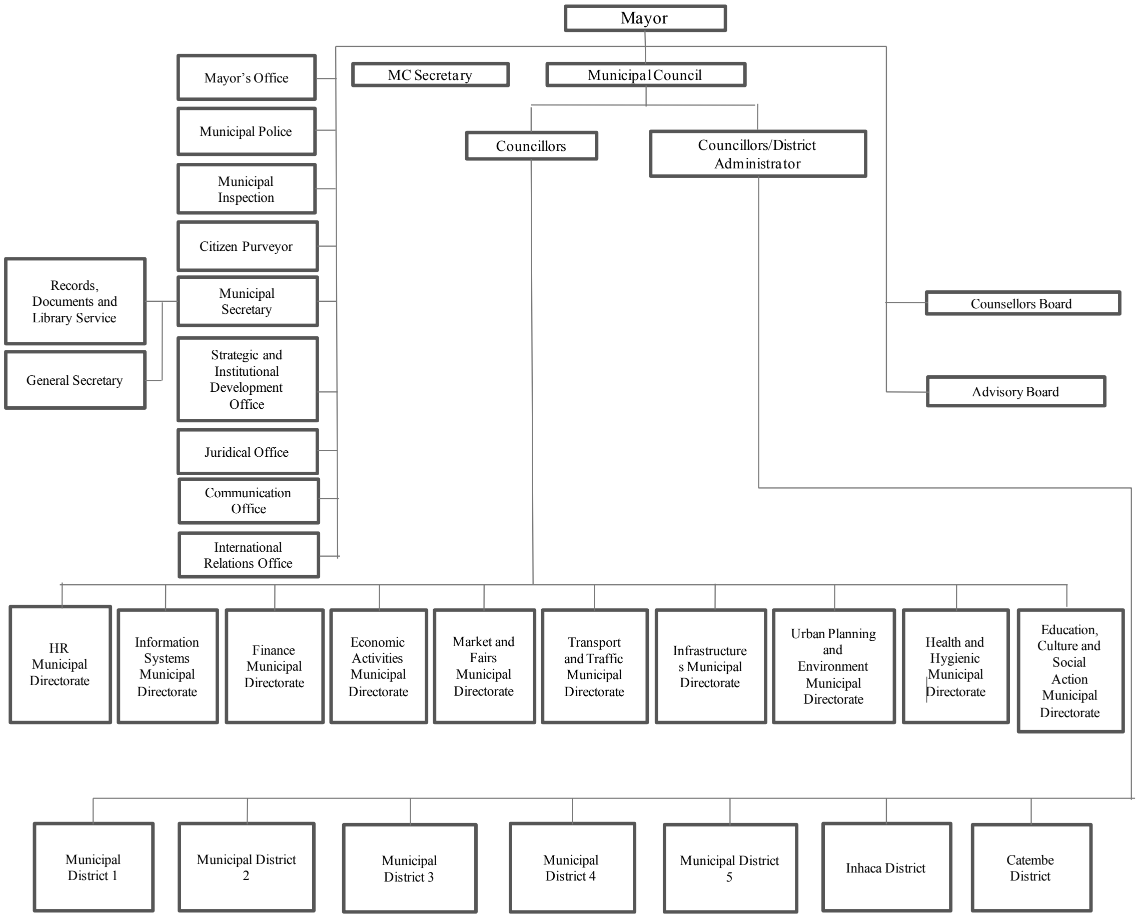
Maputo Municipality's Technical and Administrative Services are structured in various areas of activity as shown in Figure I.5. Under the terms of the No. 1, article 50 of the Law 2/97 (18 February 1997), Maputo Municipality appoints City Councilors for the following areas:

a) health and social action;
b) education, culture and sports;
c) finances;
d) infrastructures;
e) urban planning and environment;
f) human resources;
g) markets and fairs;

[1] Before 2008 there were only 33 municipalities recognized by the law, but after that the government decided to include 10 towns, one per province, amounting to a total of 43, namely: Alto Molócué, Gondola, Gorongosa, Macia, Marrupa, Massinga, Mueda, Namaacha, Ribaué e Ulongué.
[2] Ver arts. 133º e 262º da Lei da Constituição da República de Moçambique
[3] Ver art. 11º da Lei n.º 8/2003 de 19 de Maio, Lei dos Órgãos Locais do Estado
[4] In urban areas there are block chiefs which are also communitarian authorities at urban level.

h) urban solid wastes and hygiene, and cemeteries;
i) transports and traffic;
j) economic activities; and
k) seven for the municipal districts.

There are also three subordinated institutions of the Municipality: i) Municipal Police; ii) *Ntsindya* Cultural Center; and iii) Elder's Shelter. These institutions are governed by their own regulation, approved by the Municipal Assembly.



Source: JICA Project Team

Figure I.5: Organization of Maputo Municipality

I.6.4 Maputo Province

Provincial level is the second highest administrative unit under the State. The provincial government performs, for example, the following functions:[5]

- **Planning and Budgeting**: to guide the development and execution of the province's planning and budgeting; and to guide the design, execution and control of planning and budget.

[5] Ver art. 16º da Lei n.º 8/2003 de 19 de Maio, Lei dos Órgãos Locais do Estado

- **Land Use**: to authorize land use under the scope of the Land Act and its regulation; to grant special licenses in partial protection areas; and to authorize land use for areas that are under the central government bodies.
- **Public Works**: to control road development and maintenance, with the aim of ensuring the management, maintenance and expansion of the national classified road network; to control and supervise the strategic and integrated management of water resources, as well as, the supply of water and sanitation to the population. Provincial Directorate of Transport and Communications and Provincial Public Works and Housing are most relevant in the development of transport infrastructures and services of the provincial districts other than cities and towns.

Maputo Province consists of eight districts, and Matola Municipality (City) is the capital of Maputo Province. The municipality and districts highlighted in blue in Table I.6 are part of the metropolitan area defined in this project.

Table I.6: Administrative Posts, Localities and Villages in Maputo Province[6]

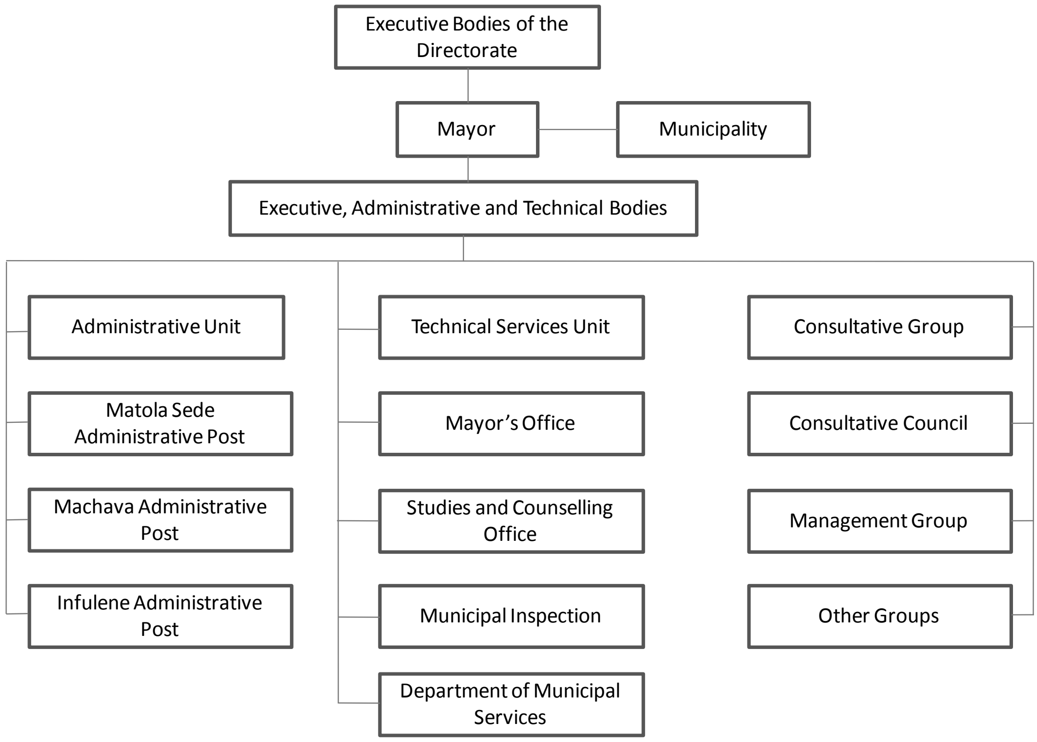
District	Administrative posts	Localities (*localidades*)	Villages
Matola City	3	0	0
Boane	2	3	31
Magude	5	9	73
Manhiça	6	13	64
Marracuene	2	5	34
Matutuine	5	11	88
Moamba	4	10	82
Namaacha	2	9	38
TOTAL	**29**	**60**	**410**

Matola Municipality consists of three urban administrative posts: Matola, Machava, and Infulene.[7] Matola Administrative Post is the one with the highest population and population density. Matola Municipal Governments and Maputo Provincial Government are located in Matola Administrative Post.

The organization of Matola Municipality Government is shown in Figure I.6.

[6] INE – Mozambique, 2007

[7] Law No 10/97, of 31 May, that creates the first 33 municipalities of city and village; Decree No 3/2008, of 2 May, that creates 10 new village municipalities; Resolution of the Council of Ministers No 7/87, of 25 April, that classifies cities in four levels; and Resolution of Council of Ministers No 55/2007, of 16 October, that elevates Matola city to Category B.



Source: JICA Project Team

Figure I.6: Organization of Matola Municipality (City)

The technical and administrative services of the Matola City are organized as follows:

a) Municipal management, legislation, regulations and by-laws;
b) General administration, finance, heritage and surveillance;
c) Urbanism, infrastructures, dwelling, basic clearance and environment;
d) Education, culture, leisure and sports;
e) Health and social action;
f) Water and power supply;
g) Transport and communications, roads and road transit;
h) Industry, trade, tourism, agriculture and fishery; and
i) Markets, fairs, gardens and cemeteries.

I.7 Organizations Relating to Urban Transport/Traffic in Greater Maputo

I.7.1 Introduction

Urban transport development in Greater Maputo involves a variety of government organizations, state enterprises, and private transport operators (Table I.7). Responsibilities of these organizations vary from policy making, planning, to licensing, and from enforcement, infrastructure development and maintenance, to operation of passenger/freight transport.

Table I.7: Organizations Involved in Urban Transport in Greater Maputo

Category	Key Organization
National Level Organizations	• Ministry of Transport and Communication (MTC) • National Land Transport Institute (INNARTEL) • Traffic Police, Ministry of Interior • Ministry of Public Works and Housing • Road Fund • ANE
Municipal Level Organization	• Directorate of Municipal Transport and Traffic (DMTT), Maputo City and Matola City • Directorate of Municipal Infrastructure (DMI), Maputo and Matola City • Municipal Police, Maputo City and Matola City
Provincial Level Organizations	• Provincial Directorate of Transport and Communication (DTC) • Provincial Directorate of Public Works and Housing (DPWH) • Division of Planning Services, Provincial District
Publicly Owned Companies	• Ports and Railway Company (CFM) • Maputo Sul • TPM • Transmaritima
Private Operators and Associations	• FEMATRO

Source: JICA Project Team

This section reviews the background and key responsibilities of the above organizations in relation to urban transport policy development in Greater Maputo, and examines issues underlying effective policy coordination.

I.7.2 National Level Organizations

(1) Ministry of Transport and Communication (MTC)

The National Directorate of Transport and Logistics is the central body of the Ministry of Transport and Communication (DTC) responsible for the coordination and supervision of the development of surface transport. The Directorate is composed by two main departments: (i) Department of Road Transport; and (ii) Department of Maritime, Fluvial and Lake Transport.[8]

Major responsibilities of the Directorate is as follows:

a) To manage, guide and control the execution of the duties of the National Directorate of Transport and Logistics;
b) To oversee the fulfillment of the laws, regulations and instructions on surface transports;
c) To support the Minister of Transport and Communications in the definition and development of policy proposals for the development of surface transport;
d) To ensure the participation in meetings of international organizations that deal with issues of surface transport; and
e) To manage the resources allocated to the National Directorate of Surface Transport, as well as patrimony resources.

[8] Boletim da República, I Serie-Numero 49, 4 December 2002

One of the two main departments under the Directorate is the Department of Road Transport which has two major divisions: Division of Road Transport for Passengers; and the Division of Road Transport for Freight. Key tasks of the department are:

a) To suggest development strategies for cargo and passengers road transport, as well as tariff policies to be applied by public companies;
b) To promote and encourage passengers and cargo road transport, through public and private companies;
c) To encourage the transformation of semi – collective transport operators into collective transport companies;
d) To propose changes or amendments of bilateral or multilateral international road transport agreements; and
e) To promote the policy of technical assistance to the existing automobile park in the country.

Key tasks of the Department of Maritime, Fluvial and Lake Transport are as follows:

a) To encourage the participation of the private sector for promoting maritime, fluvial and lake transport;
b) To instruct the process for the concession of licenses for the execution of maritime activities, procurement, stowage, stowage's support activities, naval maintenance and repairmen, professional and amateur diving, recovery of shipwreck and maritime rescue and other similar;
c) To promote actions for the implementation of maritime, fluvial and lake's transport agreements; and
d) To follow up the tariff established by the operators of the maritime, fluvial and lake transport industry.

Besides the above two main departments, the Directorate also has the Division of Studies and Planning which ensure the development and implementation of the Social and Economic Plan of the area of Surface Transport, process and centralize the statistical information, and develop studies aiming at the development of the sector. In the past, the division conducted Maputo Metropolitan Area Passenger Transport Systems Study *(Sistema de Transporte Público de Passageiros da Região Metropolitana de Maputo*: STPP/RMM) in September 2008, which recommended introduction of mass transit systems along the Matola – Maputo corridor.[9]

(2) INATTER (Formerly INAV)

In July 2011, the Cabinet approved a decree that establishes the National Institute of Road Transport (*Instituto Nacional dos Transportes Terrestres,* INATTER). This institute was established, under MTC, based on the National Road Traffic Institute (INAV) which was a public institution established in 1993 with administrative and legal autonomy, with the objective of regulating road traffic, road safety activities, the inspection of vehicles and training of drivers.[10] The institute's Board of Directors consists of 8 members representing MTC, National road council, Interior, Health, Industry, Education, Defense, and Public Works and Housing.

[9] Sistema de Transporte Público de Passageiros da Região Metropolitana de Maputo (STPP/RMM), September 2008

[10] Among many other important responsibilities, the INATTER's former organization, INAV has been active in traffic safety issues. For example, in 2004, INAV implemented a campaign with the objective of eliminating driving without license. The institute also initiated the revision of road traffic regulation in Mozambique and a campaign to promote road safety in order to raise the awareness of the civil society on the social and economic problems caused by road accidents and to invite them to participate in the fight against road accidents.

INATTER took over some of the regulatory functions currently performed by the Rail and Port Company (CFM), by the National Traffic Institute (INAV) and by the National Directorate of Transport and Logistics in the Transport Ministry.

The INNATER headquarters are in Maputo and it has branch offices in all provinces. INATTER is an institution with administrative and financial autonomy, and is a national institution whose objective is to regulate and supervise activities developed in the area of road transportation. It also aims to address the mobility needs of people and goods. The main purpose of this reform is to regulate and supervise all activities carried out in the area of land transport (essentially road and rail transport).

The transportation system development strategy intends to maximize the use of road and railway transport, in an integrated system with maritime and air transport. Thus, INATTER was established with the perspective of re-structuring the State's intervention model in the sector of road and railway transport. Hence, it was important to establish a regulatory environment that allows fair competition between the different stakeholders in this area. INATTER integrates some of the roles and competences of CFM and INAV, as well as of the National Directorate of Transport and Logistics of the MTC with regards to the regulatory component. INATTER structure integrates a Board of Directors, whose chair is appointed and discharged by the Cabinet, while the other members are appointed and discharged by the Minister for Transport and Communications.

INATTERs general management is an executive body composed of three divisions: (i) Road Services Division; (ii) Railway Services Division; and (iii) Administration and Finances Division. A Technical Council will also be set up to: (i) assess and evaluate proposals of measures with the aim of supporting, encourage and promote land transport; (ii) study and suggest appropriate ways of technical coordination with other institutions; (iii) propose more appropriate measures for the movement, supervision and safety of land transports; and (iv) analyze problems that are submitted regarding the development of road and railway transports. The Technical Council is composed of, for example, the National Director of Customs, the Managing Director of the National Road Administration (ANE), the head of the Traffic Police Central Department, a representative of the Ministry of Defence, and representation from CFM.

Major tasks of INATTER are:

a) To regulate, supervise and monitor the concession of road and railway public transport;
b) To regulate the activity of public and complementary transport, namely: to authorize, license and supervise entities that perform this activity;
c) To promote traffic and service demand research for land transportation;
d) To assist the government in the definition, implementation and evaluation of policies in the area of land transport, ensuring internal coordination with the subsystems of road and railways, and to outline intermodal circulation strategies;
e) To propose policies in the area of land transport and supervise its implementation;
f) To supervise and issue tariffs;
g) To approve and certify vehicles and equipment connected to the land transport system, including railway infrastructures, ensuring the required technical and safety standards;
h) To inspect and supervise land transport operators, driving schools, exam centres, car workshops and vehicle and tow centres, including the issuing of fines;
i) To coordinate road movements, signalling and safety activities;
j) To propose the definition of the guiding framework and regulate the access to the

activity, profession and cargo and passengers' road and railway transports market, and ensure its execution;

k) To supervise the efficient and effective use of quality standards in the training of drivers and mechanics, including the certification of their capacities;

l) To define the conditions for issuing, renewing, changing and the suspension of professional driving licenses and certificates; and

m) To assess the supervision, under the scope of its tasks, the efficiency and quality of passengers public transports services.

Under the scope of the railway service, INATTERs key tasks are:

a) To regulate the construction of railway infrastructure and encourage the participation of private operators;

b) To determine the introduction of technical enhancement in infrastructures, rolling stock, maintenance workshops, according to applicable laws and taking into consideration technical evolution, with the objective of improving safety, and efficiency in use;

c) To supervise the use of railway infrastructure and mediate emerging conflicts; and

d) To ensure and monitor the benefits of consumer interests and rights for the use of railway transport.

As of May 2012, INAV is still functioning under its original mandate, while the transition of the institute to INATTER is ongoing, with associated capacity development to cover the extended responsibilities.[11]

(3) FTC

In order to accelerate the implementation of the strategy for integrated development of the transport system, based on Councils of Ministers Decree No 38/2010 (15 September, 2010), Development Fund of Transport and Communications (FTC) has been created under Ministry of Transport and Communications. FTC is a management body to ensure a balanced, rational and sustainable management of existing financial resources and is allocated for the realization of the actions recommended. The fund is a public institution with legal personal and administrative and financial autonomy, supervised by the Minister who oversees the area of Transport and Communications. The FTC is to foster the integrated development of transport and communication systems through coordinated actions and will engage the public-private partnerships in the development of transport infrastructure, logistics, supervision and safety of transport. Funding for FTC is mainly derived from fuel tax. The use of the fund, for example, includes the acquisition of 50 large buses in 2010 for leasing out to FEMATRO, and the purchase of 150 gas-powered buses from the Indian Company Tata for use by TPM.

(4) Ministry of Public Works and Housing

The Ministry of Public Works and Housing (MPWH) is composed of five main Directorates; Administration; Finance; National Building, National Housing and Towns, and Irrigation. It also includes Housing Construction Promotion Fund. Road Fund and National Road Administration (ANE), however, these are directly placed under the Minister for Public Works and Housing, and the Ministry support these institutions budget allocations and development of strategy and policy for road national network.

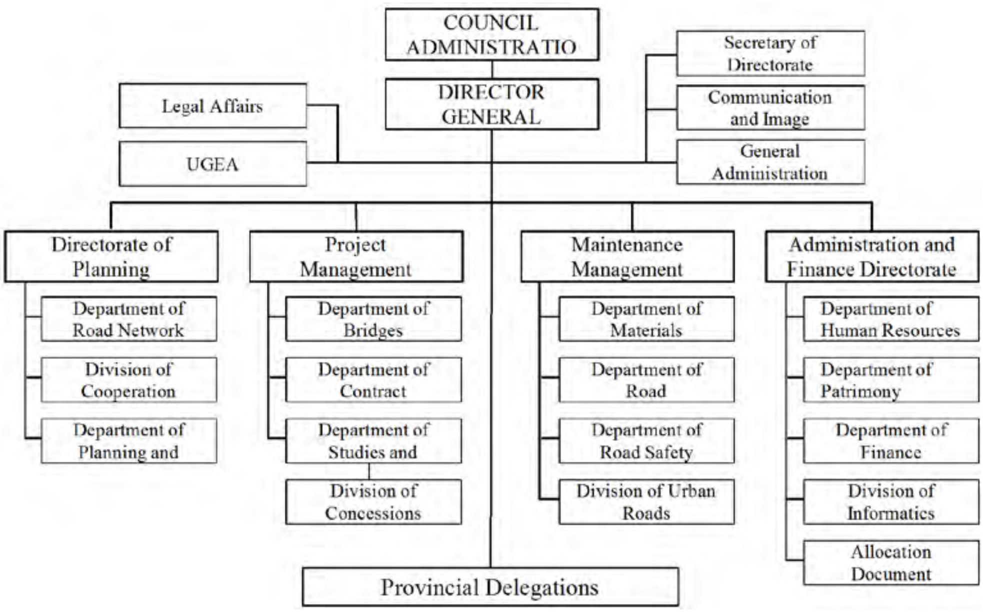
[11] As of April 2012, the process was to take at least for six more months.

(5) Road Fund

The Road Fund was established in 1992 as part of the National Road Administration (ANE), and spun off from ANE in 2003 and become an independent organization.[12] The main objective of the Fund is to address funding issues in road development in the country, and its function includes: collection of funds, budgeting, financing, and monitoring of fund receiving organizations. Source of funding comes from fuel tax, road tax, toll bridges, and foreign donors such as EU, IDA, MCC, and AfDB among many others. In year 2010 there were 77 staff, and the Fund is managing 5,787 million MT.

(6) ANE

ANE (National Road Administration) is a public institution, with legal and administrative autonomy, under the Ministry of Public Works and Housing, which is responsible for the development and maintenance of all classified roads in Mozambique and supports State's local bodies, in road related activities under their responsibility. ANE is the largest road management organization in Mozambique and its executive unit is composed by the Managing Director's office and four Directorates: Planning, Projects, Maintenance and Administration and Finances, and have four administrative departments and ten local offices in provinces as illustrated in Figure I.7. ANE has the total of 480 engineering and clerical staff.



Source: ANE

Figure I.7: Organization Structure of ANE

The objectives of the organization are: (i) to ensure the implementation of government's policies on conservation and development of public roads; (ii) to ensure a unified, efficient and effective treatment of issues related to different type of roads in the country, in order to ensure its balanced and harmonized development; and to promote and ensure an increasing participation of users and other bodies in road management. The responsibilities of ANE for classified and non-classified roads are shown in Table I.8. It should be noted that ANE does not have a direct responsibility for the maintenance or development of roads that are classified as municipal roads.

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[12] Decree 22/2003.

Table I.8: Responsibilities of ANE

Road Type	Responsibilities
Classified Roads	• To design, build and maintain classified roads • Select, following the law, service provision companies • To provide goods and execution of works • To establish and manage contractors and concession contracts of roads and its works, complying with the legislation and legal procedures
Non-Classified Roads	• To suggest rules to be complied by the municipalities in the development and maintenance of urban roads • To suggest rules to be complied by State's local bodies in the rehabilitation and maintenance of their roads

Source: ANE

The Road Policy approved by the Cabinet Resolution 50/98 (28 July 1998), defines as priorities the rehabilitation of roads and the re-establishment of the main transportation corridors, following years of continuous degradation. The vision of this policy is to improve the road network through the increase of the percentage of roads in good or reasonable condition, in order to ensure the movement of people and goods all year around. This would facilitate the flow of agriculture products from production centres to marketing centres thus contributing to the improvement of people's livelihoods. This policy is integrated with other sector-based government policies, with the goal of reducing current vehicles' operation costs and encourages the development of the country's economy.

(7) Traffic Police (Ministry of Interior)

The Traffic Police belong in the Ministry of Interior, and responsible for enforcing traffic regulations relating to parking, speeding, driving license, vehicle registration, and drunk driving. It also has responsibilities to control traffic, manage and record traffic accidents. The Traffic Police has its head quarters in Maputo City and branch offices with provincial government offices in provincial capitals. There are also traffic police officers stationed at major hospitals to deal with fatalities or injuries caused by traffic accidents. Municipalities such as Maputo City, and Matola City has their own traffic police divisions, but responsible only for enforcing the municipal regulations.

I.7.3 Municipal Level Organizations

(1) Municipal Directorate of Transport and Traffic (DMTT), Maputo City

The Maputo Municipal Directorate of Transport and Traffic (*Direcção Municipal de Transportes e Trãnsito:* DMTT) was established as a single Directorate by separating the transport and traffic responsibilities of DMI. The City Councillor for Transport and Traffic is supported by DMTT, who is responsible for developing plans and policy for municipal transport and traffic, with the aim of improving the strategic management of urban transport services (public and private).

More specifically, the key responsibilities of the Municipal Directorate of Transport and Traffic are:

a) To propose policies, management and maintenance, and operational plans of the Municipality's transport services and infrastructures, in coordination with other agencies;
b) To manage infrastructure supporting public transport (bus stops, terminals and depots);
c) To manage and grant concessions of bus/*chapa* routes;

d) To propose the introduction of fees for the use of roads and connected infrastructure and to grant concessions for its use;
e) To ensure the licensing of passenger and cargo transportation;
f) To ensure the regulation of the municipal transportation;
g) To ensure transport supervision and inspection in coordination with other entities;
h) To implement public education programmes on traffic, according to the Municipality guidelines;
i) To manage and operate urban traffic (vertical and horizontal signaling and traffic lights);
j) To propose research and studies aimed at the development of traffic and transit engineering projects;
k) To design transportation development plans jointly with other entities;

For implementing the above tasks, there are four divisions within the Directorate: (i) Licensing Department; (ii) Public Transportation Department; (iii) Traffic Engineering Department; and (iv) Administration, Human Resources and Finances Section.

(2) Municipal Directorate of Infrastructure (DMI), Maputo City

The Maputo Municipal Directorate of Infrastructure (DMI) is responsible for municipal infrastructure, and is composed of the following six departments:

a) Water and Sanitation Department;
b) Department of Construction and Urbanization;
c) Road Department;
d) Department of Buildings and Parks;
e) Department of Studies and Projects; and
f) Administrative Department, Human Resources and Finances.

The Road Department is responsible for the development and maintenance of municipal roads.

(3) Municipal Directorate for Urban Planning and Environment, Maputo City

The Municipal Directorate for Urban Planning and Environment has two major divisions in relation to land use and transport development in Maputo. These divisions include the Urban Planning Division and the Environmental Control and Management Division.

The Urban Planning Division is responsible for, among some others: ensuring the preparation and the approval of the urban structure plans and the detailed city plans; and also the monitoring of the implementation of land use plans. Responsibilities of the Environmental Control and Management Division include: supervision of requirements and the approval of environmental impact studies for projects; and designing and approving resettlement plans in coordination with the municipal service in charge of its implementation. The Directorate has a responsibility for creating and maintaining important records for the municipal management, such as land titles, environment and natural resources, various construction, infrastructure, real estate and cultural heritage.

(4) DMTT and DMI, Matola City

The organization and responsibilities of DMTT and DMI in Matola City are similar but somewhat simpler than those of Maputo City. The main responsibility of Matola DMTT, for example, is licensing for buses (*chapas*), taxis, trucks movement, motorcycles driving, and parking. Key divisions of Matola DMI are Road Department, and Public Works Department.

(5) Municipal Police

Municipal Police enforce illegal parking, *chapa* and taxi operations, and heavy track restrictions based on the municipal traffic regulations. Greater Maputo includes municipal police departments in Maputo City and Matola City. Overlapping responsibilities are observed, for example in parking enforcement, among Municipal Police and Traffic Police (Ministry of Interior). There are approximately 300 staff in the Maputo Municipal Police, of which about 100 are administration staff.

I.7.4 Provincial Level Organization

The Maputo Provincial Directorate of Transport and Communication (DTC) function as a regional office of the Ministry of Transport and Communications. There are 20 staff distributed across two divisions: (i) administration, finance, human resource; and (ii) licensing. The Directorate is responsible for the licensing of inter-city buses, (e.g. Maputo–Boane, Maputo–Manica, Maputo–Marracuene). Currently, there are about 20 routes that are licensed by the Directorate.

The Provincial Directorate Public Works and Housing (PWH) is a regional office of the Ministry of Public Works and Housing. The Directorate has about 65 staff in the following seven divisions:

a) Urban planning;
b) Finance;
c) Sanitation;
d) Procurement;
e) Building and Infrastructure;
f) Assets Management; and
g) Administration and Human Resource.

The Building and Infrastructure Division supports road and bridge development in provincial districts.

I.7.5 Publicly Owned Companies

(1) CFM

The National Ports and Railway Company (*Portos e Caminhos de Ferro de Moçambique*), also known as CFM, was established in 1989 and in the same year the National Directorate of Ports and Railways was dissolved by Government Order No. 82/76 (6 April 1976). The company manages and operates ports and railway in Mozambique. It became a public company in 1993 and is able to decide on its fare policy and implement improvement measures. There are several corridors (e.g., Sena, Beira, and Maputo) but CFM directly operates Maputo line only, and Sena and Beira lines are operated by private operators under PPP schemes. There are three international lines connecting Maputo and Swaziland (Gova Line), South Africa (Ressano Garcia Line), Zimbabwe (Limpopo Line).

The passenger train service of CFM has never been profitable due to the low level of fares and low level of service in attracting commuters. The company, however, cross-subsidizing the passenger train operation by port business in which private sector participation (e.g., Maputo Port with D.P World) has been successfully implemented.

CFM activities are managed by a Program Contract, of a minimum period of three years, between the Minister for Planning, Minister for Transport and Communications, Minister for Finance, and the President of the Board of Directors of CFM.[13]

(2) Maputo Sul

Maputo Sul Development Company is a public company with juridical, administrative, financial and patrimonial autonomy, under the Minister of Public Works and Housing. The company Maputo Sul, EP, established by decree of the Cabinet in 2010,[14] has an objective of promoting the construction, management and operation of the KaTembe bridge that connects KaMpfumo urban district and KaTembe, and the road that connects Maputo City to Ponta de Ouro and Boane to Bela Vista. A total of 20km of road improvements in southern part of Maputo City will also be undertaken by Maputo Sul.

The activities of Maputo Sul are written in a Contract Program signed for a minimum period of 3 years with the MOPH, Ministry of Planning and Development and Ministry of Finances. The Contract-Program describes, for example, strategic guidelines of the company, salaries and funding, and subsidies to be granted by the State. Construction of the KaTembe Bridge is planned to start in late 2012, with a planned completion in 2014. There are about 15–20 staff in Maputo Sul. Its organization consists of one Executive Director, and four Directors consisting of Department of Finance, Economics, Engineering, Legal, and Urban Development and Commercialization. None of the directors, however, are currently assigned yet. Maputo Sul can subscribe equity participations and establish a joint company, as long as it is authorized by the Minister of Finances, under a favourable appreciation of the Minister of Public Works and Housing.

(3) Transmaritima

Transmaritima, Limitada is a society been established by a government regulation, *Escritura Pública de Transformação da Sociedade Transmarítima, Limitada, em Sociedade Transmarítima* under Ministry of Transport and Communications. *Transmaritima* owns several ferry boats that are operating between Maputo–KaTembe, and Maputo–Matola Rio, and Maputo –Inhaka.

The objective of *Transmaritima* is to provide maritime, lake and fluvial transport in local, national and international costal passenger and freight transport services. The society can engage in other related trade and industrial activities, and if necessary, the society can charter ships as well rent its ships to third parties.

(4) Maputo Municipal Road Transport Company (EMTPM)

The Maputo Municipal Road Transport Company (EMTPM) is a municipal bus company with legal, administrative, financial and assets autonomy. The company operates in Maputo Municipality and adjacent areas. EMTPM bus fleets are mostly with 50 seats while *chapas* are mostly with 15 or 25 seats. In April 2012, there are about 380 buses operating on 60 routes.

The company was formerly called Maputo Public Transport (*Transportes Públicos de Maputo:* TPM), and used to be a state enterprise under the Ministry of Transport and Communications. TPM itself used to be part of the central government agency, but was transformed to public company as part of road public transport reform programme in 1966.[15] The bus company has

[13] The recent organizational reform involving the establishment of INATTER, this arrangement might have been changed.
[14] National Gazette, Monday, 23 August 2010 I Series No. 33.
[15] Boletim da República nº 12 1ª Série de 20/03/96.

recently been transferred to Maputo City, and part of its operation is to belong in Matola City. The objective of this company is the management and exploration of public passengers transports. It may, with the Municipal approval, develop other related activities. EMTPM is responsible for developing the set of actions aiming at ensuring in a regular, continuous and efficient manner, public transport services, including tourist transport;

I.7.6 Private Operators and Associations

(1) TRAC

The national highway connecting Maputo and South Africa (N4) has been developed and operated by a South African based private company, Trans-Africa Concessions (TRAC) Company who has a concession agreement with the Mozambique Government. The company was selected through an international competitive bidding in 1996, and signed the 30 year BOT contract with the Government in 1997. The Government's signatories are the Minister for Transport and Communication and the Minister for Public Works and Housing. The company repays the construction cost and maintain with the toll revenue. The company does not have to pay fees to the Government other than usual corporate tax. There are two toll gates in Mozambique: one is in Maputo, and another in Moamba.

The toll gate entering to Maputo from Matola is highly congested every weekday morning as there is a limited number road connecting Maputo and Matola. It is understood that the concession agreement prohibits the Government to build any new road in parallel to the TRAC toll roads other than those of minor improvements to the existing roads.

(2) FEMATRO

FEMATRO (*Federação Moçambicana das Associações dos Transportadores Rodoviários*) is a federation of 23 road transport associations in Mozambique whose main office is located in Maputo. The federation is under the National Economic Federation (*Confederação das Associações Económicas*: CTA), [16] and has branch offices in Sofala and Nampula. FEMATRO's role is to coordinate policies on private transport operation, such as fare levels and fuel subsidies, with the Government. It also organizes training programmes and dissemination of traffic regulations and government policies. The organization has a certain degree of political influence in policies relating to passenger and freight transport businesses.

The member associations include international bus operators and freight carriers other than local minibus (*chapa*) operators. One of the passenger transport associations, ATROMAP, for example, is a private legal entity with administrative and financial autonomy composed by individual and voluntary members of road passenger operators and freight transport operators in Maputo City. The member associations located within Greater Maputo include: [17]

- ATROMAP (*Associação dos Transportadores de Maputo*);
- UNICOTRAMA (*União das Cooperativas de Transportes de Matola, Matola Urbano*);
- UTLAMAP (*União das dos Transportadores de Maupto Província*); and
- ASTOROIM (*Associacao dos Transportes Inter-Provincial de Maputo*).

Passenger transport (*chapa*) operators register their business with one of the associations who coordinate routes to be operated. It is not clear that the registration with the associations is mandatory for the registration at the Municipality, or *vice versa*, and it is understood that a

[16] Source: http://www.cta.org.mz/?__target__=about
[17] Source: Federação Moçambicana das Associações dos Transportadores Rodoviários (FEMATRO)

substantial number of *chapas* are registered at the associations but not at the Municipality. Only the *chapas* registered at the Municipality can show their operating routes on their vehicles.

I.7.7 Summary

Table I.9 summarizes key functions and/or responsibilities of organizations involved in urban transport development in Maputo metropolitan area.

Table I.9: Urban Transport Organizations and Responsibilities

Organization	Key Functions and/or Responsibilities
Ministry of Transport and Communication, *Direcção Nacional dos Transportes e Logistics* (MTC)	Formulation of national policies regarding land, maritime, water transport and ports, transport strategy for passenger and cargo transport, planning of fare policies of related public corporations, facilitation of the privatization of transport businesses taking shape of consortiums/ associations, implementation of international transport agreements between two more countries and proposing changes to such agreements.
National Land Transport Institute, *Instituto Nacional dos Transportes Terrestres* (INATTER)	Formerly called *Instituto Nacional de Viação* (INAV), it is an organization under MTC responsible for vehicle registration, driver licensing, and road safety management. Within the recent organization reform, the institute is to extend its responsibilities to regulate rail transport formerly performed by CFM.
Traffic Police (Ministry of Interior)	Under the Ministry of Interior, enforces road regulations such as parking, speeding, unlicensed driving, vehicle registration, wearing of helmets, drink driving, etc.
Ministry of Public Works and Housing	Road administration is under the Ministry of Public Works and Housing in Mozambique, but since the old Road and Bridge Directorate separated and became ANE in 1999, there is no division in charge of roads. Provincial Directorate of Public Works and Housing, however, is involved in district road development.
Road Fund	A financial institution established to respond to Mozambique's road issues. Its main responsibilities include fund procurement from government and donors, budget allocation, financial management, supervision and monitoring of fund recipients, etc.
Administração Nacional de Estradas (ANE)	Established as a result of the Road and Bridge Directorate separated from the Ministry of Public Works and Housing in 1999. Its main responsibility is the development and maintenance of public roads based on government policies. In 2001, the finance department separated to create the Road Fund.
Provincial Directorate of Public Works and Housing	Support the district services of, for example, urban planning, building and infrastructure. This is a provincial office of the Ministry of Public Works and Housing
Directorate of Municipal Transport and Traffic, *Direcção Municipal de Transportes e Trãnsito* (DMTT) for Maputo City and Matola City	The main responsibilities of the DMTT of Maputo City and Matola City are issuing operation licenses to *chapa,* taxi, and truck (for freight transport) operators. Maputo DMTT has a team of engineers who plan and implement various traffic measures including improvement to intersections, signs, one-way systems and parking.

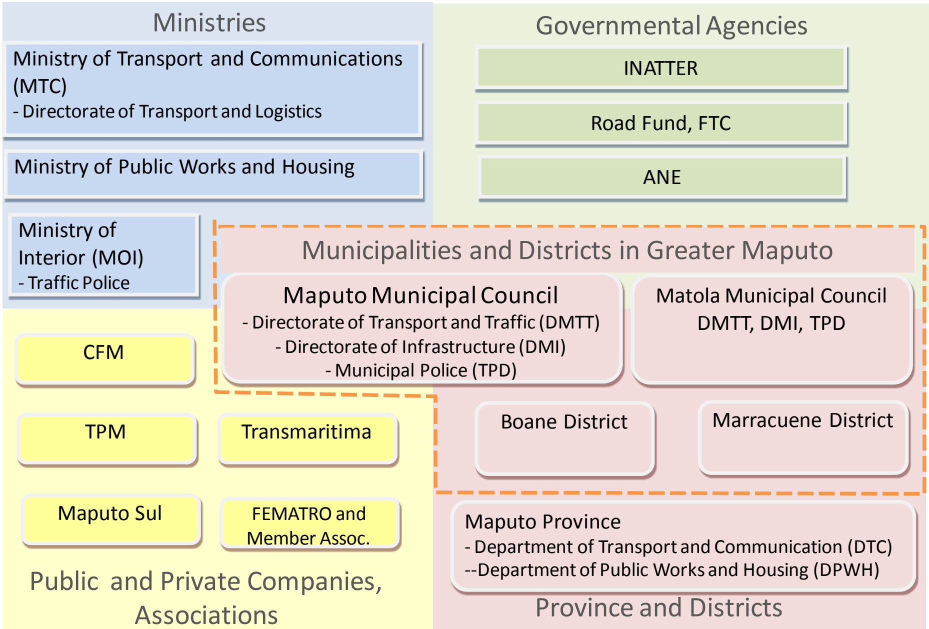
Organization	**Key Functions and/or Responsibilities**
Directorate of Municipal Infrastructure (DMI) for Maputo City and Matola City	Oversees municipal infrastructure development in Maputo City and in Matola City respectively, including roads and bridges. Budget comes from the Road Fund, as well as the city's own funding sources.
Municipal Police	The Municipal Police enforces regulations based on city ordinances such as parking violations and non-registered business vehicles (taxis, *chapas*, truck transit regulations). The municipal police does not regulate nor enforce national road laws.
Provincial Directorate of Transport and Communication	Administer licensing of inter-city buses, e.g., Maputo – Manica, Maputo – Boane, Maputo – Marracuene. There are about 20 routes licensed by the directorate. This is a provincial office of the Ministry of Transport and Communication
Port and Railway Company, *Caminhos de Ferro de Moçambique* (CFM)	Management and operation of the ports and railways of Mozambique. They also provide limited passenger service for Maputo for commuters.
Maputo Sul	The company is established under the Ministry of Public Works and Housing to promote the construction, management and further development KaTembe bridge.
Transportes Públicos de Maputo (TPM)	A public bus company mainly operating large buses within the city of Greater Maputo. The company was formerly owned by the central government, but is now under Maputo municipality (and part of operation will be split into Matola municipality in near future).
Transmaritima (ferry company)	Within the Maputo area, the company own six boats and provide a ferry service between Maputo–KaTembe, Maputo–Matola Rio, Maputo–Inhaca.
Federação Moçambicana das Associações dos Transportadores Rodoviários (FEMATRO)	A national association with 23 members for the road transport industry for passenger and cargo transport. It coordinates fare policies, tax systems (fuel levy subsidy) between the private transport companies and the government, as well as conduct training, coordinate between domestic and international businesses, and raising awareness of traffic regulations and policies. The member cooperatives include ATROMAP, UNICOTRAMA, and UTLAMAP who organize *chapa* operators in Greater Maputo.

Source: JICA Project Team.

I.8 Policy Coordination Issues in Urban Transport Development

I.8.1 Introduction

As discussed in above sections, one of the major issues regarding urban transport development in Greater Maputo is a lack of effective coordination mechanism among central, provincial, and municipal governments. The urban development plans for Maputo and Matola have been prepared within their administrative boundaries, and the provincial district adjacent to these cities is slow in catching up with the preparation of land use plans. As a result, there are no common plans or strategies for the metropolitan area that are shared among all of the relevant organizations. Meanwhile various central and municipal agencies are preparing policies and strategies, land use plans and transport projects without sufficient coordination among all the stakeholders involved (cf. Figure I.8). 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 review urban transport institution and policy coordination practices in the study area.



Source: JICA Project Team.

Figure I.8: Organizations Involved in Urban Transport Development in Greater Maputo

This section examines the existing effort to coordinate policies, review examples of urban transport institutions in other cities, and explore a direction for institutional improvements which would result in creating visions and strategies for a comprehensive land use and urban transport development that can be shared among the relevant agencies in Greater Maputo.

I.8.2 Existing Coordination Effort

Mobility Committee for a coordination of transport network development in the Maputo area has been established in 2008. The Mobility Committee was made up of 13 members from seven organizations, and was chaired by the CEO of INATTER (INAV in that time). 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. It is understood that the Committee still exists but it is not currently active.

Recently, in parallel with the preparation of this JICA project, Maputo City has 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 10 February 2012, the President of the City Council urged that Metropolitan Commission of Transport should be established an efficient, viable, and sustainable coordination mechanism. The letter stated that Maputo Metropolitan Area exceeds the boundary of Maputo Municipality, and the creation of the new Commission is necessary to support the preparation and implementation of the urban transport master plan. It is noted that coordination with INATTER is essential.

Specific issues arising from the absence of such coordinating mechanisms have been discussed during the first Policy Coordination Working Group held in April 2012 as part of training and coordination activities of this project. The issues raised in this meeting included the following:

- There is a need of defining what the Metropolitan area is and type of policy coordination required in urban transport development;
- There is a need to establish a new body for addressing metropolitan-wide transport issues including less accessible areas in the region;
- While, there is need to have a common vision for the future development of the Maputo City over the next 30 years, there is also need for ongoing immediate project coordination;
- Various transport fare levels may better be set by municipalities who provide licenses to operators;
- The roles of some of the government agencies and companies are not very clear therefore it is difficult to coordinate with them;
- Construction of new public transport corridor, for example, requires coordination with the PPP toll road company, and an arrangement for implementing the project as the municipalities cannot implement on their own;
- There is an issue of vested interests among existing organizations when establishing metropolitan level authority;
- Some major projects are initiated by the central government but relevant municipalities could not participate in the planning process;
- There is a lack to expertise among the cities and districts involved which makes it difficult to effectively discuss and coordinate technical issues; and
- Metropolitan-wide decisions should be based more on data collection and analysis.

I.8.3 Case Studies for Urban Transport Institutions

Similar issues in urban transport institutions are shared in many other cities worldwide. There are examples with ‘problems’ and examples with ‘good practices’. Examples with problems and constraints include Thailand (Bangkok), Indonesia (Surabaya, Bandung, and Denpasar), and Argentina (Buenos Aires). Those considered to be best practice examples include Hong Kong, Singapore, and Brazil (Curitiba). Table I.10 summarizes characteristics of their urban transport institutions.

Table I.10: Examples of Urban Transport Institutions in Other Metropolitan Regions

Metropolitan Region	Characteristics of Urban Transport Institutions
Examples With Problems and Constraints	
Thailand (Bangkok)	• Around 20 government departments, agencies and state-owned enterprises exercise responsibilities related to urban transport. • Agency responsibilities are will-defined and often overlapping, or competing. • This makes it difficult to form or implement a consistent policy. • This leads to fragmentation of policy/project proposals without reference to objectives of other departments or agencies. • Policy emphasis has been placed on moving traffic faster and further through a network of circuitous one-way systems and high capacity expressways, at a huge cost to pedestrians, the urban environment and mobility.
Indonesia (Surabaya, Bandung, Denpasar)	• Each city maintains a specialist Road Transport Office which is responsible for both public transport and traffic management, but professional expertise in the offices is very limited. • There is little awareness of successful transport management practices outside Indonesia, and the scope for policy initiatives is

Metropolitan Region	Characteristics of Urban Transport Institutions
	constrained by vested interests. • Central government retains ownership of large bus operation which has been a deterrent to private investment in this sector. • There is no coherent policy for managing road space, and modern principles of traffic management are not adopted.
Argentina (Buenos Aires)	• Overlapping responsibilities between national, provincial and city governments with no effective coordination mechanisms. • Urban transport policy initiated by one level of government or agency is frequently blocked by another level of government with overlapping responsibilities.
Best Practice Examples	
Hong Kong and Singapore	• Progressive transport policies have been consistently maintained for some 30 years • Effective coordination mechanisms subjugated all agencies and transport operators to basic policy objectives • Financial discipline was maintained, with all transport undertakings either privately-owned or run on commercial principles • Neither government is directly engaged in transport operations
Brazil (Curitiba)	• IPPUC was established to oversee implementation of urban master plans. • BRT corridors are developed along five linear ‘strategic avenues’ • URBS (*Urbanizacao de Curitiba*), a publicly-administrated, privately-funded company was established: (i) to regulate bus operators to run the 256 routes; (ii) sets fares and minimum frequencies; (iii) runs computerized bus scheduling system; (iv) inspects vehicles for safety; (v) conducts surveys to evaluate the performance of the system; (vi) builds and maintains terminals and bus stops; and (vii) manages the public transport fund into which all income from the operation of the buses goes.

Source: Based on GTZ, Urban Transport Institutions, Module 1b.

It is not clear at this stage, which direction Greater Maputo should (or could) proceed, but it is certain that the current absence of effective policy coordination mechanism should be improved. The next section discusses potential direction for institutional improvement.

I.8.4 Direction for Institutional Improvements

Establishment of a metropolitan authority responsible for whole Maputo Metropolitan Area is one option for consideration. Another option is the establishment of a coordinating body such as the new Mobility Committee. Successful institutional framework for assuring effective policy coordination could have the following characteristics:

- Represent the full range of local administrations in the metropolitan area;
- Effective coordination mechanism in place with Ministries, their agencies, public and private companies and operator associations;
- Capacity to develop a shared vision, and long-term strategic framework for land use and transport development in the region;
- Authority to set guidance on levels of duties and fares for transport systems operating within the metropolitan region;
- All transport plans and projects in the region would require approval of the metropolitan authority (or commission) as consistent with the integrated vision; and
- Budgeting and implementation of projects can be assigned to respective agency.

The roles of National Government in this framework in relation to metropolitan urban transport development would include the following:

- National policies and programmes for the transport sector;
- Integration of transport sector with wider economic, social and environmental policies;
- Standardization for regulations, practices and fuel and emission standards;
- Matters relating to national or international networks of road, railways and air services;
- Collecting and collating national transport system data;
- Administer national taxes and disbursing grants and subsidies for transport projects; and
- Research and development in the urban transport sector.

The national government could prepare a National Urban Transport Policy in cooperation with the metropolitan level institution. Such policy could emphasize on the following aspects:

- The transport policy maintains accessibility and mobility throughout the metropolitan areas at a cost that is affordable to all users, to governments, and society/environment.
- Restrictions on the use of private cars are required in densely developed areas where adequate public transport services should be provided.
- Organization and capacity of the public transport system is critical, as well as policy coordination among relevant government agencies.

Provincial Government could coordinate transport planning and service licensing across municipal and district boundaries, and in and out of the metropolitan area.

Each municipality and districts prepare metropolitan area related plans and programmes based on the metropolitan level policies and strategies, submit them to the metropolitan body for approval, and implement and manage projects by their own professional departments. There is a need to ensure that transport sector policies of municipalities and districts are coordinated with wider economic, environmental and social programmes and objectives

I.8.5 Consideration to the Implementation Structure of the Master Plan

Establishment of a metropolitan wide body could take several years (if at all). Meanwhile the Urban Transport Master Plan developed in this JICA project requires an appropriate institutional framework for its implementation. The following points describe preliminary idea of institutional arrangement that may be required:

- The establishment of a management/coordination unit such as a Project Management Unit will be considered which is very useful and necessary for projects with a wider range of stakeholders;
- The Steering Committee for this study project may act as the base organization for the future Project Management Unit;
- Stakeholders will exchange ideas and develop the implementation plan including decision-making processes, securing of a budget, coordination, etc; and
- Functions of a supervisory body that oversees the project implementation shall be proposed, along with relevant capacity-building training. Furthermore, the possibility of establishing an organization for regional transport planning such as a “Maputo Urban Transport Committee” should be examined.

The above ideas, however, require further discussions with relevant stakeholders.

I.9 Capacity of Key Organizations

I.9.1 DMTT, Maputo City

(1) Organization and Staff Capacity

The DMTT, Maputo City is the key counterpart organization of this JICA project, and has a total of 45 staff in the categories shown in Table I.11. Their highest academic qualifications are shown in Table I.12.

Table I.11: Number of Staff by Category, DMTT, Maputo City

Category	Number of Staff
Councilor	1
Director	1
Deputy Director	1
Head of Department	1
Senior Technician	5
Professional technician	7
Technician	5
Technical and administrative assistant	8
Assistant	16
Total	45

Source: DMTT, Maputo City, July 2012

Table I.12: Number of Staff by Academic Qualification, DMTT, Maputo City

Highest Academic Qualification	Number of Staff
Higher degree (master or doctor)	1 (Master)
University graduate	7
Mid-level professional degree	8
Grade 12	5
Grade 10	6
Grade 7 or below	19
Total	45

Source: DMTT, Maputo City, July 2012

There are 11 staff in Traffic Engineering Department with nine engineers and three assistants. Key tasks of the Traffic Engineering Department are:

a) To design proposals of plans and projects to regulate road traffic;
b) To supervise the procurement, implementation and maintenance programme of signalling boards and other traffic signals;
c) To manage, operate and maintain traffic signals;
d) To define priorities for conducting studies and projects regarding traffic lights;
e) To organize information system that allows a continuous evaluation of transportation system and road traffic; and
f) To disseminate municipal by-laws and other municipal norms on traffic and public transport and mobilize municipal staff to cooperate in supervision actions.

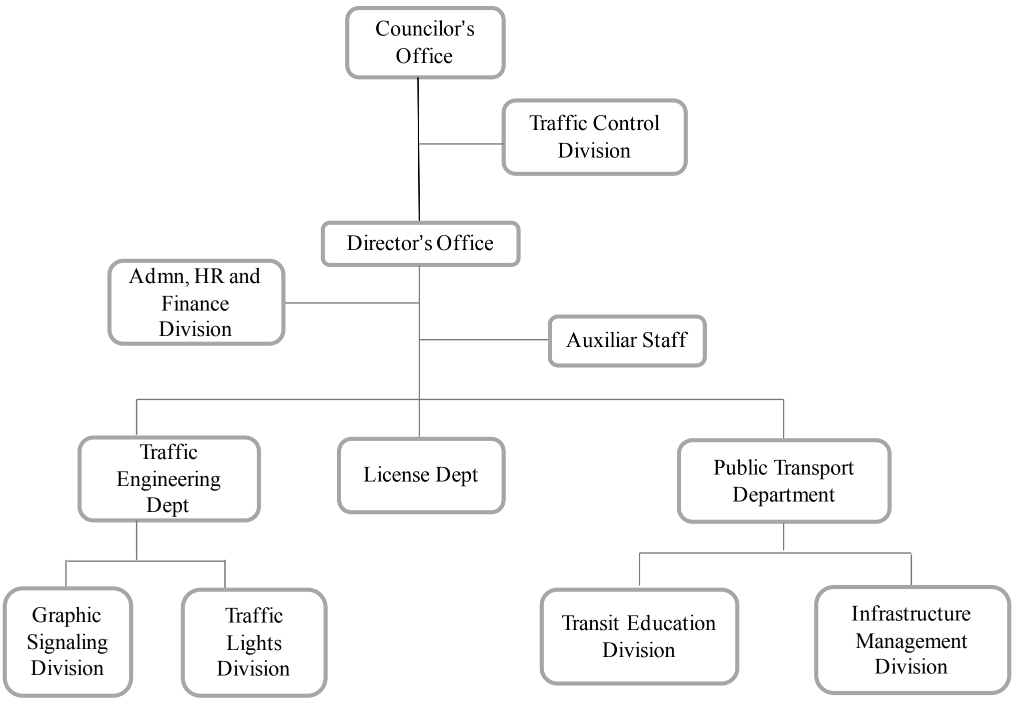
The engineers are trained in civil engineering, architecture, electrical engineering, and traffic engineering, and have adequate skills in performing day to day tasks currently assigned such as basic maintenance of traffic signs and signals and design and implementation of one-way systems and on street and off street parking facilities. However, there is only one engineer trained overseas (Master's degree in Traffic Engineering), and the remaining staff do not have sufficient knowledge and experience in conducting large scale traffic surveys, analysis and design required in the preparation of a comprehensive land use/transport master plan for the Maputo Metropolitan Area.

Key tasks of the Public Transport Department are to manage and grant concessions of public transport services, to promote studies on public transport and taxi fees, and to coordinate with the concerned authorities for implementing periodical inspections of public transport routes by ensuring safety and comfort of users. The number of staff in this department, however, is currently only one. Even though the current staff have relevant professional training experience, it is sometime difficult for them to properly perform the assigned tasks.

The License Department has eight staff consisting of specialists in law, IT and economics. The key task of the department is the issuing of licenses for the operation of *chapas*, taxis, motorcycle driving (below 50 cc), parking facilities, and truck routes/operating hours. The staff have adequate skills in performing the day to day tasks currently assigned. There are about USD 12 million worth of licensing revenues from licensing in 2010, which is put into the general account of the Municipality.

(2) Planned Organizational Structure

With assist from ProMaputo II, DMTT is currently preparing for a new organizational structure to accommodate new responsibilities including traffic signal control etc. Figure I.9 shows the planned structure and the functions of each divisions are shown in Table I.13.



Source: DMTT, Maputo City

Figure I.9: Planned DMTT Structure, Maputo City

Table I.13: Divisions and Functions for Planned DMTT Structure, Maputo City

Department/Division	Functions
Councilor's Office	• Secretary • Assistant
Director's Office	• Director • Jurist • Transport Technician
Auxiliary staff	• Driver • Assistant
Traffic Control Division	• Co-Director • Traffic Engineer • Med-level Equipment Operator Technician • Administrative Assistant • Assistant
Administration, Human Resources and Finance Department	• Head of Department • Assistant • Head of the Administration and Finance Division • Acquisitions Technician • Revenue Technician • Budget Execution Technician • Head of the Human Resources Division • Human Resources Technician
Traffic Engineering Department	• Head of the Traffic Engineering Department • Head of the Signaling Division • Senior Technician for Traffic Lights Repair • Head of the Graphic Signaling Division • Senior Technician for Graphic Signaling • Med-level Technician for Graphic Signaling • Assistant • Administrative Assistant
License Department	• Head of the License Department • Mid-level Technician • Transport Inspector • Technical Assistant
Public Transport Department	• Head of the Public Transport Department • Head of the Civic Education Division • Technician • Head of the Transport Infrastructure Management Division • Assistant
Auxiliary staff	• Driver • Administrative Assistant

Source: DMTT, Maputo City, July 2012

(3) Facilities and Equipment

DMTTs current facilities and equipment may be adequate for the currently assigned tasks, but upgrading these facilities and equipment will be necessary to fully perform the existing and new responsibilities. Within the ProMaputo II projects, new Traffic Control Centre (CCO) is under construction to undertake real time coordinated traffic operations in Maputo. The ProMaputo II also include the formation of adequate databases in order to monitor and control the vehicle fleet, which will take the forms of a digital database and control of vehicle registrations including the control of fines and restrictions.

The software needed for this control system and the associated training in the processing of the data, both for vehicle registrations and driver licensing, as well as the interface of this system with the National Database, should form an important aspect of the future capacity development programmes for DMTT.

(4) Existing Training Programmes

There are no regular training programmes at DMTT, but occasional training at domestic and overseas institutions are organized. Example overseas training courses attended by DMTT staff in 2011 are shown in Table I.14.

Table I.14: Overseas Training Courses Attended by DMTT Staff in 2011

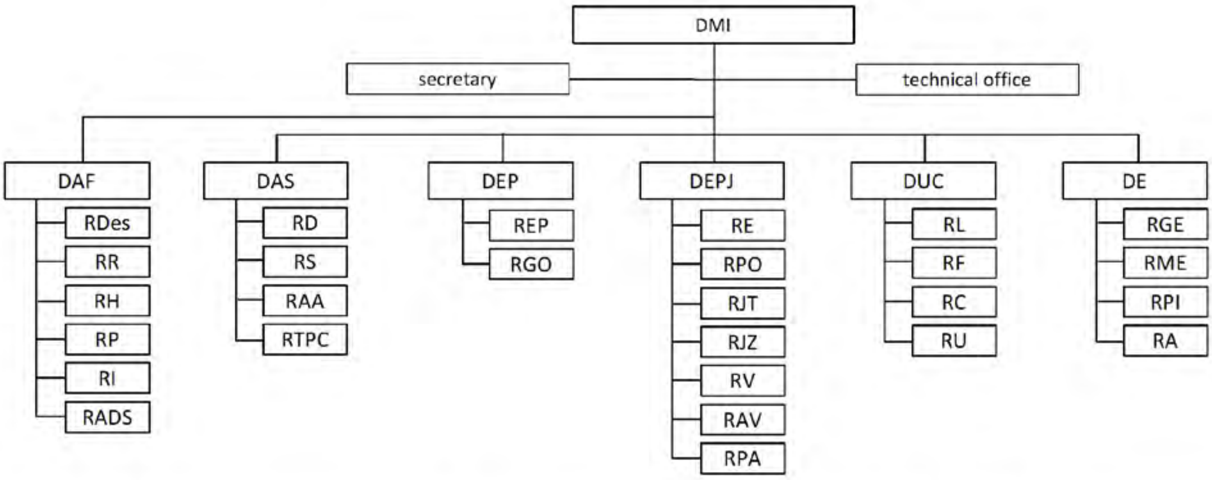
Name Category	Training course/Seminary	Country	Date
João Jorge Matlombe, Councilor	International Seminary of the Airport Cities	São Paulo/Brazil	5–8 July 2011
João Jorge Matlombe, Councilor	Urban Traffic Management and Congestion Training	Singapore	2–16 October 2011
Obadias José Djedje, Co-director	Traffic Management Training Course	South Africa	6–10 September 2011
Pedro Luís Jamal, Senior Technician N1	Concept Design of Traffic Management System	South Africa	9–11 December 2011
Pedro Luís Jamal, Senior Technician N1	11th Training Workshop for Municipal Officials of Foreign Cities	South Korea	17–27 September 2011
Pedro Luís Jamal, Senior Technician N1	Training Course for Traffic Management	South Africa	6–10 September 2011
Atanásio Alberto Tembe, Senior Technician N1	"Comprehensive Urban Transportation Planning and Project" Training Course	Japan	10 October to 12 December 2011
Jaime Benedito Simango, Senior Technician N1	"Public Works Administration in Regional Government" Training Course	Japan	4 September to 30 October 2011

Source: DMTT, Maputo City, July 2012

I.9.2 DMI, Maputo City

(1) Organization and Staff Capacity

Maputo Municipal Council is a government body which became independent from the province. The development and maintenance of various roads and streets in Maputo municipal areas are undertaken by the municipal's Infrastructure Roads Department. It has been noted that the current number of engineering staff may constrain its capacity to achieve a higher level of road maintenance given the total road length under their jurisdiction. The organizational chart of the Maputo Municipal Council Infrastructure Department is shown in Figure I.10.



DAS	Water and Clearance Department	RS	Clearance Division	RPA	Arboreous Park Division
DEP	Study and Projects Department	RAA	Water Provisioning Division	RL	License Division
DEPJ	Buildings, Parks and Gardens Department	RTPC	Slopes and Coastal Protection Division	RF	Inspection Division
DUC	Urbanization and Construction Department	RADS	Records, Documents and Secretariate Office	RC	Condominiums Division
DE	Roads Department	REP	Studies and Projects Division	RU	Urbanization Division
DAF	Administration and Finance Department	RGO	Works Management Division	RGE	Roads Management Division
RDes	Expenses Division	RE	Buildings Division	RME	Roads Maintenance Division
RR	Revenues Division	RPO	Publicity and Decoration Division	RPI	Planning Division
RH	Human Resources Division	RJT	Tunduru Garden Division	RA	Provisioning Division
RP	Heritage Division	RJZ	Zoological Garden Division		
RI	Investments Division	RV	Nursery Division		

Source: Maputo Municipal Infrastructure Department, July 2012

Figure I.10: Organization Chart of Maputo Municipal Infrastructure Department

The DMI, Maputo City is one of the key counterpart organizations of this JICA project. The Maputo DMI has a total of 131 permanent staff in the categories shown in Table I.15. Their academic qualification (highest) including seasonal labourers (402 staff), such as, road operators, gardeners, cleaners, drains cleaners, is shown in Table I.16.

Table I.15: Staff by Category, DMI, Maputo City

Category	Number of Staff
Councilor	1
Director	1
Deputy Director	4
Senior Technician	–
Professional technician	43
Technician	7
Technical and administrative assistant	33
Assistant	42
Total	131

Source: DMI, Maputo City, July 2012

Table I.16: Academic Qualification of Staff, DMI, Maputo City

Highest Academic Qualification	Number of Staff
Higher degree (master or doctor)	3 (Masters)
Bachelors	16
University graduate	30
Mid-level professional degree	43
Grade 12	7
Grade 10	33
Grade 7 or below	401*
Total	533

Note: *Majority of the staff in this category is seasonal labourers, such as, road operators, gardeners, cleaners, drains cleaners
Source: DMI, Maputo City, July 2012

Responsibilities of the Road Department are: (i) to suggest policies and management and maintenance operational plans for the Municipal roads, in coordination with other entities; and (ii) to manage and maintain urban roads and connected infrastructure. Additional capability currently suggested includes the ability: to ensure monitoring the execution of works conducted by a third party on the road network; and to promote studies, execution and maintenance of works of transportation infrastructures.

Key tasks of the Department of Urbanization and Construction are: (i) to suggest urbanization, construction and housing policies and operational plans in the Municipality; (ii) to ensure the urbanization of areas through the construction of public infrastructure, taking into account locally approved land planning; and (iii) to establish and manage support technical information systems for a safe land attribution.

Major responsibilities of Department of Studies and Projects are: (i) to conduct studies regarding the preparation and implementation of projects of municipal buildings and equipment; (ii) to ensure the technical specifications necessary for the procurement of goods and services related to approved projects; and (iii) to implement population resettlement plans and activities covered.

(2) Facilities and Equipment

The facilities and equipment at DMI, Maputo City require a major upgrade. Existing equipment is said to be outdated and old fashioned. The Municipality plans to provide 10 new computers to DMI which will be distributed among six directorates. This is considered to be insignificant compared to the real needs. Currently there is no systematic road maintenance programme at DMI. The Directorate is currently trying to implement a SGEN programme which will help the departments to share information, and help workers to access different files from their working place. A database is being prepared in DMI to share information among its six departments.

I.9.3 DMTT and DMI, Matola City

The DMTT, Matola City is responsible for licensing of *chapas* based in Matola, parking, motorcycle, etc. and currently has seven staff in the categories shown in Table I.17. Academic qualification of the staff is at the mid level, but the counsellor is currently attending a university course.

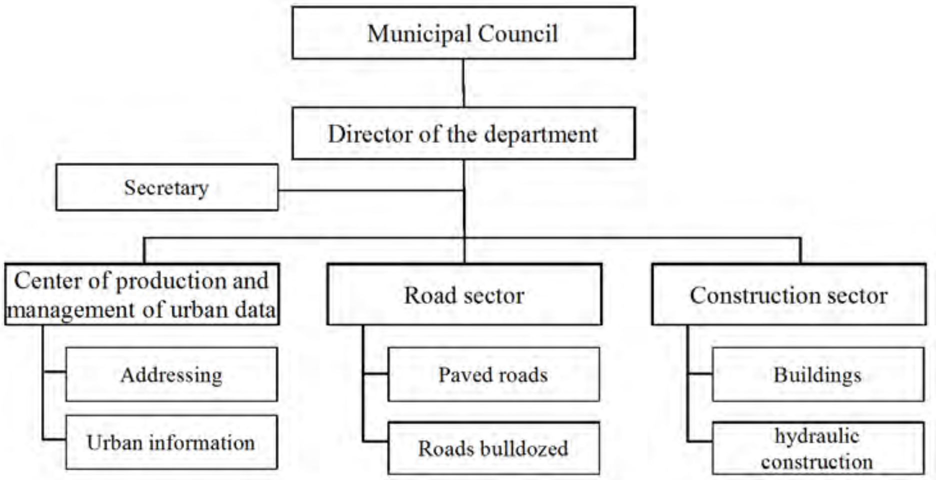
Table I.17: Staff by Category, DMI, Maputo City

Category	Number of Staff
Councillor	1
Director	1
Technician	5
Total	7

Source: DMTT, Matola City, July 2012

Matola DMTT do not have a traffic engineering division. Traffic management and control tasks are completed by the Municipal Police, Matola City. Most of the Matola DMTT staff do not have formal training in transport and traffic except the Director who was a TPM staff and attended a training course provided by DMTT, Maputo City in late 1990's.

Matola DMI managed, develop, and maintain Municipal roads in Matola City, but have a relatively small number of engineers without proper training in the areas of roads and bridges. The organizational structure of the Matola DMI is shown in Figure I.11, and the number of staff in key divisions are shown in Table I.18.



Source: Matola Infrastructure Department, July 2012

Figure I.11: Organization Chart of Matola Municipal Infrastructure Department

Table I.18: Number of Staff in DMI, Matola City

Contents	Engineer	Other	Total
Road Division	0	24	24
Construction Division	4	13	17
Centre for Production and Management of Urban Data	4	1	5
Total	8	38	46

Source: DMI, Matola City, July 2012

Urban and Lad Use Department of Matola consists of 9 divisions, and has total of 52 staff (Table I.19).

Table I.19: Divisions and Functions for Urban and Land Use Planning Department, Matola City

Division	Staff
Councilor's Office	1
Director's Office	1
Planning	7
Survey and Registry	3
Cartography	1
Topography	12
Building Permit	9
Office of Secretary	14
Information Office	4
Total	52

Source: Matola City, July 2012

Academic qualification of staff is summarized in Table I.20.

Table I.20: Academic Qualification of Staff, Urban and Land Use Planning, Matola City

Highest Academic Qualification	Number of Staff
Higher degree (master or doctor)	1 (Masters)
Bachelors	11
University Graduate	3
Mid-level professional degree	10
Grade 12	13
Grade 10	13
Grade 7 or below, unknown	1
Total	52

Source: Matola City, July 2012

I.9.4 Boane[18] and Marracuene Districts

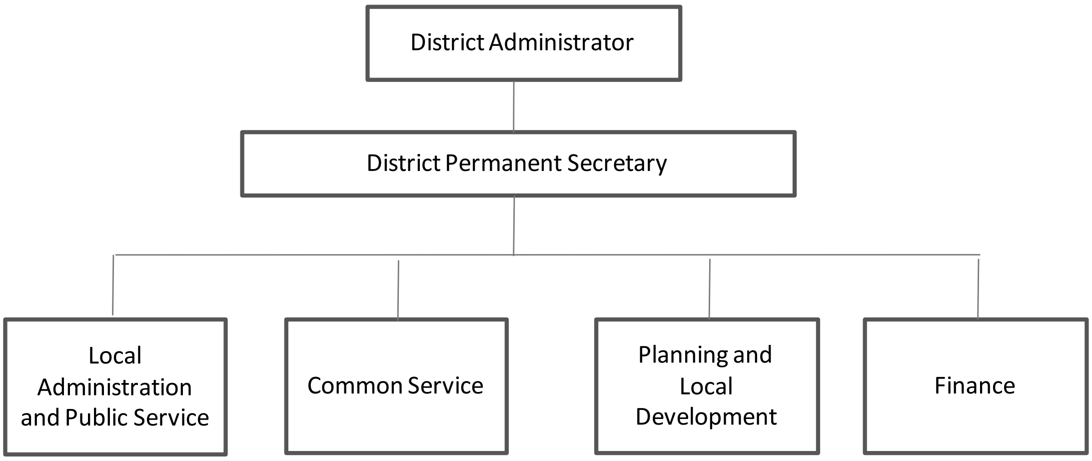
Boane consists of four departments (Figure I.12) and has staff of 98 whose academic qualifications are shown in Table I.21. Marracuene District has the same organizational structure as in Boane.

Table I.21: Academic Qualification of Boane Staff

Highest Academic Qualification	Number of Staff
Higher degree (master or doctor)	-
Bachelors	5
University Graduate	2
Mid-level professional degree	16
Grade 12	-
Grade 10	10
Grade 7 or below, unknown	65
Total	98

Source: Matola City, July 2012

[18] Information in this section is based on information on Boane District. As of August 2013, Boane District became a municipality.



Source: District Office, July 2012

Figure I.12: Organization Chart of Provincial District (Boane, Marracuene)

I.9.5 Capacity Gap Assessment

Maputo City has used its own funds to implement various measures that were recommended by the 2001 Road Development Plan for Maputo City, displaying an example of the high utilization of master plans by the city. While recognizing the need to update these existing plans, and recognizing the need to implement and update the Master Plan, the counterpart agencies including Maputo City seeking to acquire necessary skills by their own staff.

Throughout this study, various capacity development initiatives have been or are currently being implemented. These include on-the-job training, workshop and working group activities, and informal training to relevant organizations to strengthen necessary skill to prepare urban transport plans/projects including the design and implementation of transport/traffic surveys. The project also assessed the direction of capacity-development activities that need to be implemented by the relevant agencies beyond the study period.

Skills necessary for the preparation and implementation of an urban transport master plan are also identified as shown in Table I.22.

Table I.22: Skills Necessary in the Preparation and Updating of an Urban Transport Master Plan

Subject	Necessary Skills
Comprehensive Land Use/Transport Planning	• Setting an urban development vision • Setting urban development scenarios (setting land use pattern in each development scenario) • Setting composition of major transport systems in each land use pattern • Setting socioeconomic and population frameworks for each growth scenario • Evaluation of growth scenarios by a demand forecasting model • Establishment of an urban transport master plan strategy (planning of transport management, followed by selection of a mass-transit system, in order to select most appropriate development scenario) • Preparation of an implementation plan • Preparation of plan and implementation organization

Subject	**Necessary Skills**
Traffic Surveys and Data Management	• Confirmation of basic issues regarding traffic surveys (survey planning, timing for revision of relevant information, sub-contract related matters (methodologies for bidding and TOR preparation, quality control on sub-contractors, etc.)) • Household Interview Survey • Other traffic surveys • Sampling methodology • Methodology for analysis • Transport database/GIS
Demand Analysis	• Zoning • Preparation of current network • Preparation of current OD matrix • Preparation of trip generation and distribution model • Preparation of trip model by mode • Network assignment of current traffic volume
Public Transport Systems and Operation	• Public and private bus system • Challenges and measures for bus transit • Roles of taxi, train and ferry services • Bus operations • Methodology for rearrangement plan of bus routes • Tariff system • Bus priority lanes, priority signals, bus stops, bus terminals, information system of bus users • Roles of public and private, implementation of concessionaire
Mass Transit Planning	• Characteristics of subways, LRT and BRT and examples of implementation plan and its standards • Methodology for BRT system plan • Selection of routes • System planning • Intermodal facilities • Demand forecast • Operation plan • Consideration of PPP projects • Feeder planning • Tariff collection • User information system • Related transport management plan • Cost estimate and economic and financial analysis
Traffic Management	• One-way system • Parking management • On-street parking control • Improvement of pedestrian conditions • Traffic control, licensing system • Traffic accident analysis, points with frequent accidents • Road safety • Improvement of intersection, installation of traffic signals, control system, control centre • Facilities for pedestrian safety • Traffic demand management (staggering office hours, HOV lanes, road parking management, area licensing, etc.) • Area licensing
Transport Institutions and Capacity Development	• Coordination of urban transport measures and its challenges (Example of urban transport authority/committee and its applicability) • Required skills and capacity development programmes

Subject	Necessary Skills
Project Implementation and Procurement	• Regulations and institutions/organizations • Evaluation of master plan and other ongoing projects • Establishment of project implementation plan • Financial plan • Project management • Procurement management • Construction management • Monitoring and maintenance management plan
Highway Planning, Design and Maintenance	• Design standard • Road plan • Pavement technology and maintenance programme • Maintenance system • Overload management
Economic and Financial Analysis	• Economic cost (capital investment, operation cost) • Calculation of profit (time-base profit, reduction of operation cost) • Economical rate of return, net present value, cost-benefit ratio • Financial analysis methodology for profit-making project • Sensitivity analysis
Social and Environmental Analysis	• Awareness of environmental laws in Mozambique • Environmental Impact Assessment (basic knowledge, its preparation , subcontracting, evaluation and analysis) • Strategic Environmental Assessment (basic knowledge, its preparation, subcontracting, evaluation and analysis) • Social consideration (related laws, basic knowledge (the World Bank Operational Policy) • Stakeholder meetings (basic knowledge, planning, operation, implementation) • Pollution control • Environmental management plan • Introduction of similar cases

Source: JICA Project Team.

During an assessment of capacity development, assistance by other donors in this sector has also been reviewed so that the recommendations will complement the past and ongoing programmes.

One of those programmes is found by the ProMaputo by the World Bank. The first component (institutional reform and governance), all 29 organizational units of the municipality were restructured, human resources management plan was developed and implementation started, and district level authorities also received capacity building support to plan and manage small scale infrastructure and urban services. This component also prepared a public private partnership strategy, and recommended the installation of a public private partnership unit in the municipality. The second component (municipal finance) assisted in the improvements in municipal revenue collection and expenditure management. The third component (planning and service delivery) mainly focused on planning and management urban space, and completion of the urban structure plan. The municipal Geographic Information Systems (GIS) and associated cadastres were also developed. This component also implemented improvements to some urban roads and solid waste management.[19] Some of the ProMaputo I components will be continuing under ProMaputo II which commenced in January 2011 and to be completed in 2015.

The objective of the Second Maputo Municipal Development Program Project for Mozambique (MMDP or commonly known as ProMaupto I), which was initiated in April 2007 and completed in August 2011, supported the development of the Maputo Municipality through the

[19] World Bank, Maputo Municipal Development Program, Implementation Completion and Results Report, 28 February 2012.

strengthening of Maputo City council's institutional and financial capacity to achieve long term service delivery goals and to implement selected priority investments. There were three main components in ProMaputo I: (i) institutional reform and municipal governance; (ii) municipal finance; and (iii) planning and service delivery improvements.

I.10 Roles of Educational Institutions in Capacity Development

I.10.1 Introduction

Despite continuing efforts to improve the educational level of its population, Mozambique is still facing an acute shortage of people with higher-education. In 1999, total enrollment in higher education was 11,600, but the total number of new higher education graduates in Mozambique was only 483 in 1998. The result is that out of over 100,000 civil servants (excluding the armed forces), only about 3% have a degree, almost all of whom are based in Maputo. Furthermore, 52% of managers do not have the academic qualifications required for their jobs.[20]

Transport is a multi-disciplinary sector, utilizing a range of technical skills in monitoring, analysis, forecasting, planning and design. Many of these skills have their basis in civil engineering and statistics, but specific applications in transport usually require post-graduate education.

Increasing the supply of qualified staff at relevant organizations should be the responsibilities of higher level educational institutions. There are several higher education institutions in Mozambique, but few are providing transport and traffic related courses. This section reviews relevant courses available and number of students at three Maputo based institutions: (i) Eduardo Mondlane University (UEM); (ii) Higher Institute of Transport and Communication (ISUTC); and (iii) Transport and Communications Institute (ITC).

I.10.2 Eduardo Mondlane University (UEM)

The School of Engineering of the Eduardo Mondlane University (UEM) was established in 1962 with a centralized leadership structure, with each course linked to a specific department. Immediately after the independence, the departments were transformed into 'Schools' with a non-centralized structure but with a close inter-school relationship. Currently, in all its departments, the School of Engineering provide eight honour degree courses in the areas of Civil Engineering, Electric Engineering, Electronic Engineering, IT Engineering, Mechanic Engineering, Industrial Management Engineering, Chemical Engineering and Environment Sciences Engineering.

The Roads I course in Civil Engineering aims at providing curriculum with which students will gain the following skills and knowledge:

- Clear concepts in criteria to design land courses (roads, paths, ways, passages, etc);
- Capability in designing layouts of roads and railways in terms of geometry; and
- Knowledge in defining transversal and longitudinal road construction works.

[20] United Nations, Public Administration Country Profile, Republic of Mozambique, January 2004, p.11.

Table I.23: Topics and Hours in Roads I Course at the School of Civil Engineering, UEM

Topic	Theory	Practice	Weekly	Laboratory	Total
A- Overall Component					
1. Introduction	3	2	2		7
2. Resistance to Movement	2	2	2		6
3. Overall Technical Features Roads	3	3	3		9
4. Geometry of Roads	4	6	6		16
5. Infrastructures	3	3	3		9
6. Field Recognition	2	2	2		6
7. Drainage Of Works	4	4	4		12
B- Special Component					
8. Characteristics of Soils	2	2	2	4	10
9. Mechanical Stabilization	4	4	4		12
Total	30	31	21	4	96

Source: School of Civil Engineering, UEM

The Roads II course in Civil Engineering aims at providing curriculum with which students will gain the following skills and knowledge:

- Concepts on the dynamics of pavements at its design;
- Capability on designing, theoretically and in practice, pavements;
- Skills regarding visual observation of pavements; and
- Knowledge in detail all aspects related to quality control of pavements.

Table I.24: Topics and Hours in Roads II Course at the School of Civil Engineering, UEM

Topic	Theory	Practice	Weekly	Laboratory	Total
A-Basic principles					
1. Tensions in flexible and inflexible pavements	2	2	2		6
2. Traffic	2	2	2		6
3. Climate, environment, and resistance capacity of the substructure	3	3	3		9
4. Design and analysis strategy of systems and economic factors	2	2	2		6
B-Design of pavements					
5. Flexible pavements	4	4	4		12
6. Inflexible pavements	4	4	4		12
C-Visual observation, evaluation and rehabilitation of pavements					
7. Damaging of existing pavements	3	3	3		9
8. Visual observation	3	3	3		9
9. Maintenance of existing pavements	3	3	3		9
D-Quality control					
10. Testing of materials and execution of works	2	2	2		6
11. Interpretation of statistical assessment of results	2	2	2		6
12. Receptive conditions	2	2	2		6
Total	32	32	32		96

Source: School of Civil Engineering, UEM

As it is seen in the above course topics, sufficient hours are spent in road engineering courses but no transport planning or traffic engineering topics are provided. The number of students who can learn at UEM is also limited. The Civil Engineering course at the Eduardo Mondlane University (UEM) offered 40 places and ratio of candidates per place was 4.7 in the year 2000.

I.10.3 Higher Institute of Transport and Communication (ISUTC)

Regardless of a higher tuition fees, because of the high social demand and the inability of the public sector to respond, these private institutions are filling up and important role in the systems. The Higher Institute of Transport and Communication (*The Instituto Superior de Transportes e Comunincações*: ISUTC) is a private Higher Education Institution providing transport related subjects since 2000, and is the 8th oldest higher institutions in the country. The Technical Higher Institute (*The Instituto Superior Técnico*: IST) in Portugal is the model of ISUTC. The Institute is considered to be the same level as a university but with a fewer number of specialized courses providing as compared to a university. The institution focuses on subjects relating to transport and communication, and provides honours degrees and master courses in the areas of civil engineering, transport and communication.

The ISUTC was established by Transcom, a private company in South Africa; its establishment was approved by the Cabinet Decree 32/99 and the first school year was 2000/2001 with honours degree courses in IT Engineering and Telecommunication and Financial Management. In 2001 it introduced honours degree courses in Civil Engineering and Transport and in 2006 in Mechanic Engineering and Transport. The institution has trained, up to now, a number of honours degree holders in the area of transport. ISUTC has 530 students and graduates about 350 students each year.

Master degree courses were started in 2009, with a course of Network Engineering and Communications Systems, which was followed by Post graduate courses in Management of Telecommunication Companies. A masters course in Transport and Communication was started in 2011. Currently, the institute lectures a total of 11 courses, out of which 5 are honors degree, 4 master degrees and 2 post graduate degrees.

Table I.25: Degree and Courses at ISUTC

Degree	Course
Honors Degree	• Accounting and Audit (LCA) • Civil and Transport Engineering (LECT) • IT and Telecommunications Engineering (LEIT) • Mechanical and Transport Engineering (LEMT) • Management and Finance (LGF)
Masters Degree	• Master in Management of Construction Projects • Executive Master in Management for Engineers • Executive Master in Banking Management • Master in Network Engineering and Communication System
Post Graduate Degree	• Railway Engineering • Management of Telecommunication Companies

Source: ISUTC

There are four main courses which provide subjects related to transport and traffic at ISUTC (Table I.26).

Table I.26: Transport and Traffic Related Courses at ISUTC

Course	Subject
Mechanic and Transport Engineering	• Operations and Logistic System, • Transport Technology and Traffic Engineering, • Basic of Transport Engineering and Management of Fleet
Civil and Transport Engineering	• Road Network and Construction Technology • Spatial Planning and Urban Management • Basics of Transport Engineering • Planning and Management of Transport Systems
Management and Finances	• Transport and Logistics
IT and Telecommunication Engineering	• IT and Telecommunication Engineering

Source: ISUTC

Table I.27 shows the new programme on Transport and Communication provided in the year 2011/2012.

Table I.27: Master Course on Transport and Communication at ISUTC, 2011–2012

Module	Topic	From	To
1	Transport Systems	7 March	18 March
2	Design of layout in transport infrastructures	9 March	20 March
3	Construction technology in ground leveling	13 June	24 June
4	Pavements' construction technology	18 July	29 July
5	Management of transport company	22 August	2 September
6	Maintenance of roads and airfields	19 September	30 September
7	Road traffic engineering	24 October	4 November
8-A	Road and airport pavements	5 December	16 December
8B	Railway engineering	5 December	16 December

Note: This programme is for 2011/2012
Source: ISUTC

The cost of the courses is relatively high comparing to public universities,[21] therefore only a limited number of students can enroll. There were only eight students in engineering courses. The cost of running courses are said to be also high for the institution and government support is essential. One of the advantage of engineering courses at ISUTC, however, is that the institute places an emphasis on field activities therefore the graduates can start working relatively easily in engineering companies, banks, or consulting agencies.[22] ISUTC provides scholarships to students who cannot afford paying the whole cost for studying.

ISUTC has 12 full time and 70 part-time lecturers due to the limitation in funding. ISUTC has the intention of expanding the courses but cannot afford paying for lecturers because foreign lecturers are expensive and the institution does not have the support from the Mozambican Government.

I.10.4 Transport and Communications Institute (ITC)

The Transport and Communications Institute (ITC) is a vocational medium level private institution, established in 1998, by the company Transcom, SA. Its shareholders are: FERNAVE and Entreposto Comercial de Moçambique, Telecomunicações de Moçambique (TDM) Moçambique Celular (Mcel), Linhas Aéreas de Moçambique (LAM) and Aeroportos de Moçambique (ADM). The objective of this institute is to train medium level technicians to

[21] Around 6,000 to 9,000 MT per month.
[22] Based on an interviews to Prof. Leite at ISUTC.

companies in the sectors of Transport and Communications and its complementary (Accounting and Management, IT, HR, etc). The qualification obtained is Medium Technician, which is equivalent to grade 12.

Three courses related to transport are provided in this institute as shown in Table I.28.

Table I.28: Transport Related Courses at ITC

Course	Subject
Accounting and Management	• Accounting and Management • IT systems • Transport Management • HR and Marketing • Industrial Maintenance • Electro-mechanic Systems
Transport Management	• Transportation modes I and II • Marketing e Commercial Management of Transport I and II • Management of Transportation Systems • Accounting and Financial Calculus I and II • Corporate Administration I and II • Information Systems and Management
Vocational Component	• Transportation • Management of Transport and Cargo I and II • Accounting I and II • Corporate Administration and transport Marketing I and II • Management information systems

Source: ITC

I.11 Summary of Institutions and Capacity Development Issues

The above sections reviewed the administrative system in Mozambique and sections that follow describe functional responsibilities of transport and traffic organizations, and their policy coordination issues. Preliminary findings from the capacity assessment of key institutions, and higher education institutions were also presented. This section summarizes key findings of the above analyses.

Key findings in institutional and capacity development issues in urban transport development in Greater Maputo can be summarized as follows:

a. Need for an improved metropolitan level policy coordination mechanism;
b. Need for a clearer demarcation of regulatory responsibilities in transport licensing across administrative boundaries;
c. Requirement for capacity development of key organizations in Maputo City;
d. Requirement for capacity development of key organizations in Matola City, Boane City, and Marracuene District; and
e. Requirement for strengthening higher education institutions in the provision of transport and traffic related courses.

Each of the above issues is elaborated in the following paragraphs.

- *Need for an Improved Metropolitan Level Policy Coordination Mechanism*: 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 little 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. Possibility of establishing a metropolitan level transport authority (commission) may have to be examined.

- *Need for a Clearer Demarcation of Regulatory Responsibilities in transport licensing across Administrative Boundaries*: Currently, private bus licenses are issued by municipalities and provinces. The licensed routes, however, could extend to the administrative boundary where those licenses are issued. Private buses registered in Maputo City, for example, could operate across the boundary in Matola, and buses registered in Matola could also 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 have to be addressed through the metropolitan level urban transport institution mentioned above.
- *Requirement for Capacity Development of Key Organizations in Maputo City*: Under ProMaputo I and II the Maputo Municipal Government undertook organizational reform and capacity development programmes. Part of its achievement is the improvement in land use planning capability. Infrastructure planning and implementation capacity have been relatively strong and the 2001 JICA project for Maputo assisted in preparing a road network development plan. In recent years, transport and traffic capabilities have also been improved by creating a department responsible for this sector by separating a unit from the department in charge of infrastructure in general. The traffic engineering division 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. Public transport division, however, may have to be substantially strengthened in terms of number of staff and their skills to perform its designed tasks. Capacity development programmes to fill these gaps would help strengthen these key organizations.
- *Requirement for Capacity Development of Key Organizations in Matola City, Boane City, and Marracuene District*: Matola City, have weaker organizational capacities as compared to the organizations with similar functions in Maputo City. There is a shortage of qualified staff. Boane City and Marracuene District have limited number of technical staff and have to depend on provincial government for their transport infrastructure development. Since there is an urgent need to improve metropolitan wide policy coordination, the divisions with similar functions among municipalities and districts should cooperate with each other to develop policies, strategies, plans and projects extend across the metropolitan area. The capacity development programmes mentioned above could include strengthen key divisions of these organizations as well.
- *Requirement for Strengthening Higher Education Institutions in the Provision of transport and Traffic related Courses*: Subjects on road network development has been included in most of the civil engineering courses in Mozambique but the number of students is considered to be small compared to the society needs. While qualified staff is in short in government agencies, higher education institutions providing transport and

traffic courses are extremely limited in Mozambique. At UEM, sufficient hours are spent in road engineering courses but there is no course specialized in transport planning or traffic engineering. A private institution in Maputo, ISUTC, has courses in transport and communications but there is no courses specialized in transport planning or traffic engineering subjects. Although higher degrees can be obtained overseas on these specialized subjects, there are needs and opportunities in improving capacity of domestic education institutions to include more subjects relating to transport and traffic studies.

Attachment 1:

Capacity Assessment and Training Needs

Capacity Assessment of Counterpart Staff, and Training Requirement

Responsibility	Tasks	Level of knowledge and skills of counterpart staff to perform tasks at the beginning of this project	Training target to be achieved within this project	Training provided within this project	Requirement for continued support after the project
Integrated Urban Transport Planning	• Setting composition of major transport systems in each land use pattern • Setting socioeconomic and population framework for each growth scenario • Evaluation of growth scenario by demand forecast model • Establishment of urban transport master plan strategy (planning of transport management, followed by selection of mass-transit system, in order to select most appropriate development scenario) • Preparation of implementation plan • Preparation of plan and implementation structure	Counterpart staff understand the nature of an integrated urban transport planning, but possess limited knowledge and skills on performing each tasks	Overall urban transport planning process is clearly understood	Workshop on modeling and informal seminars on data requirements were organized Procedures of integrated urban transport planning process will be clearly understood by at the end of this project	Continued support is required to gain more detailed knowledge and skills for updating the master plan and conducting feasibility studies It is preferred that key staff would receive formal training on this subject
Land Use Planning	• Review of existing land use information • Review of ongoing development plans and projects (district land use plans, updates to structure plans, urbanization plans, Housing Fund projects and private sector development projects) • Setting urban development vision • Setting urban development scenario (setting land use pattern in each development scenario)	Counterpart staff of Maputo Municipality is technically capable of land use and urban planning. With the support of the World Bank PROMAPUTO, necessary measures of slum upgrades and formalization are underway. Detailed GIS mapping of Maputo Municipality has also been completed under WB assistance. While there is much process within Maputo Municipality boundaries, coordination with neighboring Matola Municipality and the Disticts	Methods of setting development visions and scenario has been transferred through coordination with the municipalities and districts, central government agencies, donor and consultant though consultancy meetings and working group activities	On-the-job trainings and individual consultancy meeting to collect relevant urban and land use data were performed. Working group meetings on urban development vision and scenario were held twice in collaboration with socio-economic framework and environment specialist, in which discussion techniques were transferred to the counterpart.	Continued technical assistance is required especially in the area of improving coordination between the neighboring city/districts and consolidation of information into a database.

Responsibility	Tasks	Level of knowledge and skills of counterpart staff to perform tasks at the beginning of this project	Training target to be achieved within this project	Training provided within this project	Requirement for continued support after the project
		of Boane and Marracuene are still weak, and the weak capacity of the neighboring city/districts are a major challenge			
Socio-Economic Analysis	• Collection of existing socio-economic data • Preparation of socio-economic indices for demand modeling	Counterpart staff understands the nature of collecting relevant socio-economic data. They are not familiar with the preparation of data to be used in demand modeling	Methods of socio-economic data collection and analysis and discussion process with relevant stakeholders will be understood clearly.	On-the-job trainings to collect relevant socio-economic data were performed. Working group meetings on socio-economic framework were held twice. Workshop on formulating urban development scenario from socio-economic framework was organized, in which discussion techniques were transferred to counterpart.	Continued support is required to gain more detailed knowledge on data analysis of formulating future socio-economic framework.
Traffic Survey and Analysis	• Confirmation of basic issues regarding traffic surveys (survey planning, timing for revision of relevant information, sub-contract related matters (methodologies for bidding and TOR preparation, quality control on sub-contractors, ect.)) • Household Interview Survey • Other traffic surveys • Sampling • Methodology for analysis • Transport database/GIS	Counterpart staff have knowledge and skills of designing and conducting some of the traffic surveys, but limited knowledge on other surveys such as household interview surveys	Methods and purposes of various surveys, necessary analyses , and their use in demand modeling are clearly understood	Workshop on traffic surveys, modeling and informal seminars on data requirements were organized On the job training will be continued throughout the project	

Responsibility	Tasks	Level of knowledge and skills of counterpart staff to perform tasks at the beginning of this project	Training target to be achieved within this project	Training provided within this project	Requirement for continued support after the project
Demand Modelling	• Zoning • Preparation of current network • Preparation of current OD matrix • Preparation of trip generation and distribution model • Preparation of trip model by mode • Network assignment of current traffic volume	Counterpart staff knows about importance of demand modeling, but have limited skills on actually using modeling software	Provide training for a better understanding of steps required in modeling	Copy of STRADA software has been provided and explanation of functions of each module has been explained Training will be provided during model building process	
Road Network Planning	• Review of design standard • Review of existing condition • Analysis of issue and problems • Preparation of road network plan • Pavement technology and maintenance program • Improving maintenance system • Overload management	Counterpart staff has engineering knowledge and skills on road network planning, their maintenance system is below standards.	Overall road network development planning process is clearly understood.	Method of road network planning and a systematic maintenance process have been presented at the WG meetings. This activity will be continued during the remaining project period	Continued technical assistance is is required to improve maintenance process
Public Transport Planning	• Public and private bus system • Challenges and measures for bus transit • Roles of taxi, train and ferry services • Bus operations – its role • Methodology for rearrangement plan of bus routes • Tariff system • Bus priority lanes, priority signals, bus stops, bus terminals, information system of bus users • Roles of public and private, implementation of concessionaire • Characteristics of subways, LRT and BRT and examples of implementation plan and its standards • Methodology for MRT system plan	Counterpart has limited knowledge on public transport planning and management but has shown initiative in developing this knowledge through reading and research.	Counterpart understands overall process of public transport planning and management in the context of integrated urban transport planning	Knowledge transfer through involvement of counterpart in interviews with transport operators and regulatory authorities; discussion of public transport issues, problems and potential measures to address them; and one-on-one discussion of public transport planning principles including terminal design, industry structure, fares and subsidies.	Counterpart needs to become more directly involved in public transport planning and regulatory processes, but needs to be relieved of routine administrative tasks through the appointment of additional subordinate staff. Implementation of recommended measures for improvement will require external technical assistance, and this should involve close collaboration with the counterpart staff.

Responsibility	Tasks	Level of knowledge and skills of counterpart staff to perform tasks at the beginning of this project	Training target to be achieved within this project	Training provided within this project	Requirement for continued support after the project
	• Selection of routes • System planning • Intermodal facilities • Operation plan • Consideration of PPP projects • Feeder plan • Fare policy • User information system • Related transport management plan • Cost estimate and economic and financial analysis				Counterpart has applied for, and been offered, a place on a Master's Degree course in Transport Policy and Planning at the University of Newcastle-upon-Tyne in the UK, but is still seeking funding. This application should be fully supported.
Traffic Management and Control	• One-way system • Parking management • On-street parking control • Improvement of pedestrian conditions • Traffic control, licensing system • Traffic accident analysis, points with frequent accidents • Road safety • Improvement of intersection, installation of traffic signals, control system, control center • Facilities for pedestrian safety • Traffic demand management (staggered working hours, HOV lanes, road parking management, area licensing, etc.) • Area licensing	Staff at DMTT Maputo are capable for designing and implementing basic traffic management measures such as one-way systems, intersection improvement, tidal flow arrangement. Improved knowledge and skills are required to design and implement more advanced traffic management measures	Full knowledge of Parking surveys, demand and duration. Analysis of accident data.	Training in Parking surveys, demand and duration. Training in traffic capacity analysis and saturation at signals. Training in traffic signal area control techniques. Training in the use of Accident Data. Training in the use of Sampling Traffic Data.	Training in the use of Area Traffic Control software tools (TRANSYT). Training in the use of Accident Data software

Responsibility	Tasks	Level of knowledge and skills of counterpart staff to perform tasks at the beginning of this project	Training target to be achieved within this project	Training provided within this project	Requirement for continued support after the project
Institution and Capacity Development	• Institutions and organizational issues in urban transport • Coordination of urban transport policies/implementation in a metropolitan area • Establishing urban transport authority/committee (international practices) • Role of higher education systems in capacity development of transport professionals	Counterparts are aware of the importance of the institutions and capacity development, but have limited knowledge on the way how the relevant actions can be taken	Counterpart will gain knowledge on improvement options through international good practices	Improvement options through international good practices are (being) presented and actively discussed among the counterparts	Support is required to implement proposed institutions and capacity development measures
Project Implementation and Management	• Regulations • Institution and organization design • Evaluation of master plan and other ongoing projects • Establishment of project implementation plan • Financial plan creation and use in managing results • Project management plan and techniques • Procurement management • Construction management • Monitoring and maintenance management plan	Counterparts are likely to include MMTA, ANI, DMI, DMTT, certain Maputo City Councilors and SPCs established to implement certain projects; counterparts have good experience and knowledge in implementing existing regulations, creating annual and 3-5 year financial plans, procurement and construction management. Improved skills may be needed in drafting new regulations to facilitate Master Plan implementation, institution and organization design, effective monitoring and management of plan implementation (Master Plan, Financial Plan, Project implementation plans).	Counterparts will gain knowledge in designing legislation to responsibly implement projects (MP and other) and designing institutions and organizations for effective performance. In particular counterparts will consider how to determine the appropriate organization for a given project (existing Agency, new Agency, SPV, etc.). Counterparts will also be exposed to techniques for monitoring plans and budgets and using them to actively manage improved outcomes	Working groups, seminars and small group training on: • Best practices: regulatory, organization design, choice of organization. • Using budgets and plans to actively manage project execution. • Techniques for creating and monitoring maintenance plans. • Latest approaches/ideas in project planning, financial planning in the context of the MP and other project plans.	Support for monitoring performance on a continuing basis;

Responsibility	Tasks	Level of knowledge and skills of counterpart staff to perform tasks at the beginning of this project	Training target to be achieved within this project	Training provided within this project	Requirement for continued support after the project
Economic and Financial Analysis	• Economic cost (capital investment, operation cost) • Calculation of profit (time-base profit, reduction of operation cost) • Economical rate of return, net present value, cost-benefit ratio • Financial analysis methodology for profit-making project • Sensitivity analysis	Counterparts have good knowledge and experience in P&L management. There is a perceived lack of experience with project focused financial analysis such as cost/benefit analysis, investment rate of return and economic value compared with financial value	Counterparts will gain knowledge in the concepts of project financial analysis, conducting project financial analysis and using project financial analysis as an input to project approval decisions.	Working groups, seminars and small group training on: • Financial and Economic Returns • Identifying and quantifying economic costs and benefits • Net present value definition and use in project evaluation; determining an appropriate discount rate • Using sensitivity analysis to identify risk to project success	Support in conducting post project financial reviews focused on factors influencing actual performance compared with estimated performance.
Social and Environmental Impact Analysis	• Awareness of environmental laws in Mozambique • Environmental Impact Assessment (basic knowledge, its preparation , subcontracting, evaluation and analysis) • Strategic Environmental Assessment (basic knowledge, its preparation, subcontracting, evaluation and analysis) • Social consideration (related laws, basic knowledge (the World Bank Operational Policy) • Stakeholder meetings (basic knowledge, planning, operation, implementation) • Pollution control • Environmental management plan • Introduction of similar cases	Counterpart staff who belongs to Environmental Management Department of PPUA, Maputo Municipal Council has basic knowledge about environmental regulations and laws of Mozambique, EIA including its process, Stakeholder meetings, etc.	Counterpart staff is expected to obtain full understanding of SEA, needs of cross-sectoral coordination for environmental matters in the Greater Maputo.	Periodic working group meetings, a role of facilitator given at workshops (capacity building to share and consolidate environmental/social issues) with other relevant officials. - **1st WG**: 28 March 2012 - **2nd WG**: 8 Aug 2012 - **Joint WG** (with Urban Planning): 5 July 2012 - **Joint WG** (with Urban Planning): 7 Nov 2012	Strengthening of coordination and implementation capacity among relevant officials for sustainable urban transport development. Improvement of GIS skills, not only how to use, but also how to cooperate with other department/institutions in order to minimize duplication of works and to improve effective use of GIS data.

Attachment 2:

Training and Workshops

1. Introduction

The technology transfer tasks of this project are being implemented through working group meetings, workshops, and other informal thematic training. Several working groups were created to discuss various issues among relevant organizations relating to the formulation of the master plan. In addition, the knowledge transfer from project experts to local counterpart officials was carried out through the working group activities. A total of five working group meetings were held. While a working group meeting typically consists of several participants, larger capacity development activities were undertaken through workshops. The first workshop on urban transport planning, traffic survey methodology, demand analysis, and data management has already been successfully implemented in early July 2012. While the working group meetings and workshops are formally organized with invitation letters and agenda, more informal training was also implemented which focused on specific subjects and/or technique required in the preparation process of urban transport master plan. These informal thematic training sessions were mainly provided to the project counterpart staff.

2. Working Group Meeting

The following five working group meetings were organized:

a. Household Interview Survey
b. Introduction to SEA
c. Public Transport
d. Road Network Development
e. Policy Coordination
f. SEA and information of outcomes of the Progress Report
g. Socio Economic Analysis
h. Urban Transport Development: Visions and Strategies
i. Urban Development: Visions and Strategies, and SEA consideration
j. Institutions and Capacity Building.

Table 1 summarizes the above working group activities.

Table 1: Summary of Working Group Activities to Date

Working Group (*Sector*)	Date, Objective, Participants, and Agenda
Household Interview Survey (*Traffic Survey*)	Date: 30 March 2012 Participants: • INE • Matola Municipal Council • CMM – Maputo • JICA Team Agenda: • Overview of Household Interview Survey • Implementation Schedule (all surveys) • Appointment of Agencies to be Involved in Working Group for Survey Preparation and Clarification of their Roles • Important items and names of agencies involved
Introduction to SEA *(Environmental and Social Analysis)*	Date: 28 March 2012 Objectives: Implementation of SEA requires involvement of various stakeholders, and it is necessary to share the concept of SEA, as well as to exchange ideas among the participants further develop the SEA methodology and its implementation. Participants: • Technical officers from Maputo Municipal Council • Technical officers from Matola Municipal Council • Technical officers from Marracuene District Office • Technical officers from Boane District Office • Technical officers from ENGC • Technical officers from MICOA • Faculty members from UEM • JICA Project Team Agenda: • Introductory Presentation about Strategic Environmental Assessment, including its role for the Project • Public consultations for SEA in each city/district ➢ Implementation schedule ➢ Request from the JICA Project Team for cooperation for its implementation ➢ Discussion: points to be aware before planning public consultations ➢ Discussion: methodology for information dissemination for conducting public consultations
Public Transport (*Public Transport Planning*)	Date: 5 April 2012 Objectives: Transfer of expertise; input to Master Plan from stakeholders; creation of a team of people to assist with Master Plan implementation regarding public transport development. Participants: • DMTT, Maputo City • Representative from UTROMAP • Representative from ATROMAP • Representative from TRANSMARITIMA • Representative from Marracuene Municipality • Representative from TPM • JICA Project Team

Working Group (*Sector*)	**Date, Objective, Participants, and Agenda**

	Agenda:
	• Public transport issues to be addressed
	    ➢ the need for an integrated public transport system serving the entire urban area (study area);
	    ➢ different public transport modes and their roles;
	    ➢ route planning principles;
	    ➢ roles of public and private sectors;
	    ➢ regulation of services;
	    ➢ fare and subsidy policy
	• Priority issue
	Output: Summary of findings and proposals on each issue

	Date: 10 May 2012 Objectives: To discuss issues relating to bus fares in Greater Maputo Participants: • DMTT, Maputo City • ULTRAMAP • ATROMAP • Marracuene Municipality • Matola Municipality Agenda: • Summary of main points discussed in first WG meeting • Bus fares in Greater Maputo Area • Closing Remarks (note: representatives of ULTRAMAP and ATROMAP refused to discuss bus fares since FEMATRO was in discussions with the municipality on this issue).
	Date: 22 June 2012 Objectives: To discuss issues relating to bus fares in Greater Maputo (not discussed at previous meeting) and other public transport issues. Participants: • DMTT, Maputo City • Marracuane Municipality • Matola Municipality • CFM • Transmaritima Agenda: • Bus and Chapa Fares • Traffic Congestion • Public Transport Management
	Date: 27 July 2012 Objectives: Follow up on issues discussed at previous meetings, in absence of JICA Public Transport Specialist Participants: • DMTT, Maputo City • TPM • CFM • ATROMAP • Maputo Municipality • Matola Municipality • JICA Project Team Agenda: • Issues arising from previous meeting • Public Transport Fares and Subsidies

Working Group (*Sector*)	Date, Objective, Participants, and Agenda
	• Traffic Congestion • Public Transport Management • Any Other Business
Road Network Development *(Road Network Planning)*	Date: 17 April 2012 Objective: Coordinate among the stakeholders to exchange information and discuss about road network improvement measures. Participants: • ANE • Maputo Municipal Council / Infrastructure department • Matola Municipal Council / Infrastructure department • Marracuene District Office • Boane District Office • JICA Project Team Agenda: • Introductory Presentation about the Function of Road and Road Network • Issue on road network development • Potential issue expected in future • Road development issues in each region • Discussions
	Date: 26 July 2012 Objective: Information sharing of road network issue and exchange of opinions of Design standard. Participants: • ANE • Maputo Municipal Council / Infrastructure department • Matola Municipal Council / Infrastructure department • Marracuene District Office • Boane District Office • JICA Project Team Agenda: • Presentation and discusses about issue of existing road network • Discussion about local design standard • Questionnaire of traffic congestion points
Policy Coordination (*Institutions and Capacity Development*)	Date: 18 April 2012 Objective: Discuss existing situations, issues, and improvement options on policy coordination on urban transport development among the relevant municipalities, districts and other organizations. Participants: • Councillor for DMTT, Maputo City • Director for DMTT, Maputo City • Representative from Matola city • Representative from Marracuene district • Representative from INATTER • UEM • JICA Project Team Agenda: • Transport and traffic related organizations in Maputo Metropolitan Area • Existing status of policy coordination in Maputo metropolitan area • International experience in policy coordination • Discussion

Working Group (*Sector*)	**Date, Objective, Participants, and Agenda**
SEA and information of outcomes of the Progress Report (Environmental and social analysis)	Date: 8 August 2012 Objective: The working group on environmental and social analysis will be updated with findings regarding environmental and social issues for the Project, with information of SEA that will be utilized when urban development vision and strategies for urban development and urban transport are being developed in October/November 2012. Stakeholders who shall be invited for SEA process are also being discussed and determined among the group. Participants: • Maputo Municipal Council • Matola Municipal Council • Marracuene District • INGC • Traffic Police • Municipal Police • JICA Project Team Agenda: • Presentation to the Environmental Working Group, including: Outcome of Progress Report of the Project, clarification of environmental and social considerations needed for the Project, and etc. • Identification of stakeholders, clarification of SEA for the Project
Socio Economic Analysis (Socio Economic Analyst)	Date: 2 August 2012 Objective: The working group on socio-economy presents the existing socio-economic conditions, future socio-economic framework including population projection and GDP/GRDP projection, and invite participation from relevant stakeholders on the socio-economic framework in the Master Plan. Participants: • Maputo Municipal Council: • Marracuene District Administration • Ministry of Planning and Development • Ministry of Transport • National Institute of Statistics • JICA Project Team Agenda: • Existing Socio-Economic Conditions • Future Socio-Economic Framework • Discussion on Urban Development Scenario for Master Plan based on Socio-Economic Framework
	Date: 18 September 2012 Objective: The working group on socio-economy presents the future socio-economic framework such as population, GDP/GRDP, Car Ownership, Enrolment, Employment, which are necessary for transport demand forecast. Future urban scenarios and transport options based on socio-economic framework are discussed among relevant stakeholders, and the input and comments from relevant stakeholders as to future development framework and urban scenario are sought after. Participants: • Maputo Municipal Council: • Marracuene District Administration

Working Group (*Sector*)	Date, Objective, Participants, and Agenda
	• Boane District Administration • Ministry of Planning and Development • Ministry of Transport • National Institute of Statistics • Ministry of Education • JICA Project Team Agenda: • Future Socio-Economic Framework • Discussion on Urban Development Scenario for Master Plan based on Socio-Economic Framework
Urban Transport Development: Visions and Strategies *(Urban Transport Planning)*	Date: 31 October 2012 Objectives: To discuss draft urban transport visions and strategies Participants: • DMTT • Matola City • Boane District • Marracuene District • Maputo Sul • FEMATRO Agenda: • Concept of visions and strategies, and their role in the master planning process • Presentation of draft urban transport visions and strategies • discussions
Urban Development: Visions and Strategies, and SEA consideration *(Land Use Planning and SEA)*	Date: 7 November 2012 Objectives: Participants: Agenda:
Institutions and Capacity Building	Date: 19 November 2012 Objectives: To discuss scope of proposed Institute of Transport Traffic Studies Participants: • Matola City • ISUTC Agenda: • Presentation on proposed Institute of Transport Traffic Studies • Discussions
	Date: 20 November 2012 Objectives: To discuss scope of proposed Metropolitan Maputo Transport Authority Participants: • Matola City • INARTTEL Agenda: • Presentation on proposed Metropolitan Maputo Transport Authority • Discussions

Source: JICA Project Team.

3. Workshops

The first workshop was held on 7 June 2012 from 0900 to 1600 hours at Kaya Kwanga, Rua D Joao de Castro, 321 – Maputo. Objectives of the first workshop was to inform stakeholders progress of the JICA study, provide knowledge on fundamentals of urban transport planning, traffic survey methodology, demand analysis, and data management. There were total of 56 participants.

Table 2: Agenda for the First Workshop

Time	Programme	Resource Person
09:00–09:15	Introduction and Welcome Remarks	João Matlombe
09:15–09:45	Project Information and Progress	Hiroshi Aoki
09:45–10:30	Fundamentals of Urban Transport Planning and Transport Modeling	Chiaki Kuranami & Richard Di Bona
10:30–10:45	Tea Break	
10:45–11:30	Transport Surveys, for each survey in turn	Kazuhiro Fujita & Obadias Djedje
11:30–12:15	PANEL DISCUSSION: Data collection and analysis urban transport policy decisions Session Chairman: Prof. Matos Panelists: Joao Matlombe, Hiroshi Aoki, Chiaki Kuranami	
12:15–12:30	Explanation of Breakout Group Session	Joaquim Tembe
12:30–13:30	Lunch	
13:30–14:30	Breakout Session Groups • Group 1: Understanding Travel Patters: Household Interview Survey • Group 2: Addressing Traffic Problems: cordon, screen line, intersection counts, travel speeds and parking surveys • Group 3: Improving Public Transport Systems: bus and chapa surveys, user interview surveys • Group 4: Database Management and GIS:	 Lloide Massangaie & Kazuhiro Fujita Obadias Djeje & Richard Di Bona Atanasio Tembe & Chiaki Kuranami Hiroshi Aoki & Sergio Malo
14:30–15:00	Summary Presentation from Each Breakout Group (5 minutes per group)	
15:00–15:15	Closing Remarks	Vereador João Matlombe

Source: JICA Project Team.

The second workshop was held by the JICA Project Team and counterparts on 9 August 2012. There were 55 attendees including representatives from relevant organizations, as well as the mayor of Maputo Municipality, the Chief Representative of JICA Mozambique, and members of the press.

The main objective of the second workshop was to identify and analyze urban transport issues in Greater Maputo. In particular, issues that require immediate attention (i.e. urgent/short-term issues), those that need to be gradually tackled or will otherwise become serious challenges in the near future (medium-term issues), and those that will become extremely serious issues if left unaddressed (long-term issues) were identified and differentiated. Possible measures to address such challenges were proposed and organized according to the length of time required the measures to be implemented.

Table 3: Agenda for the Second Workshop

09:00–09:15	**Registration**
09:15–09:30	**Introduction and Welcome Remarks** João Matlombe, Councilor, DMTT Maputo Ryuichi Nasu, Resident Representative, JICA Mozambique **Opening Remarks** David Simango, Mayor, Maputo Municipal Council
09:30–11:00	**Urban Transport Issues & Challenges in Maputo:** *Chaired by Prof. Matos, UEM* ➢ **Presentation 1: Road Network:** *Yuzo Nakano, Road Planning Specialist, JICA Project Team* ➢ **Presentation 2: Public Transport:** *Richard Iles, Public Transport Specialist, JICA Project Team* ➢ **Presentation 3: Traffic Management and Control – Parking/Safety:** *Alan Cannell, Traffic Management Specialist, JICA Project Team* **Q&A**
10:50–11:00	**Distribution of Groups**
11:00–11:15	**Coffee Break**
11:15–12:45	**Round Table Session 1: Sector Issues and Potential Improvement Measures** ***Table 1: Roads*** *DMTT Facilitators:* **Jaime Simango,** *JICA Project Team Lead:* **Yuzo Nakano, Hiroshi Aoki** *Translator:* **Tatiana Ibraimo,** *Scribe:* **Natsuko Kikutake** ***Table 2: Public Transport*** *DMTT Facilitators:* **Atanásio Tembe and Lóide Massangaie** *JICA Project Team Lead:* **Richard Iles, Chiaki Kuranami, and Kazuhiro Fujita** *Translator:* **Lucia Alberto Fumo,** *Scribe:* **Tomoko Tauchi** ***Table 3: Traffic Management and Control – Parking/Safety*** *DMTT Facilitators:* **Obadias Djeje, and Jaime Simango** *JICA Project Team Lead:* **Alan Cannell** *Translator:* **Not needed,** *Scribe:* **Marcia Guambe** *Floating:* ***Councilor João Matlombe, Prof. Matos, Richard Di Bona, Asuka Yoshioka, Joaquim Tembe, Sergio Maló***
12:45–13:15	**Summary of Group Discussion:** *Chaired by Prof. Matos, UEM*
13:15–14:00	**Lunch**
14:00–15:30	**Round Table Session 2: Main Themes in Planning and Implementation Process** ***Table A: Socio-Economic Framework and Infrastructure Financing*** *DMTT Facilitators:* **Catrina Armando** *JICA Project Team Lead:* **Akiko Abe, Yuzo Nakano** *Translator/Scribe:* **Tatiana Ibraimo** ***Table B: Land Use and Development Visions*** *DMTT Facilitators:* **Idálio Juvane + Eng. Costa** *JICA Project Team Lead:* **Natsuko Kikutake, Sérgio Maló** *Translator/Scribe:* **Joaquim Tembe** ***Table C: Environment and Social Impacts*** *DMTT Facilitators:* **Raul Chilaule** *JICA Project Team Lead:* **Tomoko Tauchi, Alan Cannell (Road Safety)** *Translator/scribe:* **Márcia Guambe** ***Table D: Institutions and capacity building*** *DMTT Facilitators:* **Carlos Diante and Adelino Cruz** *JICA Project Team Lead:* **Chiaki Kuranami** *Translator/scribe:* **Lúcia Alberto Fumo** *Floating:* ***Councilor João Matlombe, Prof. Matos, Hiroshi Aoki, Richard Di Bona, Asuka Yoshioka***
15:30–16:00	**Summary of Group Discussions:** *Chaired by Prof.Matos, UEM*
16:00–16:15	**Closing Remarks** Councilor João Matlombe

Source: JICA Project Team.

4. Other Informal Training Activities

Several other informal training activities have been organized for DMTT staff. Some of these have been requested from the counterpart staff and the JICA Project Team responded to their request by using existing materials.

Table 4: Summary of Informal Training Implemented

Date	Subject (Sector)	Organization Involved (Number of Participants)
March 2012	Preliminary meeting for 1st environmental working group meeting	DGIA-CMM (1) JICA Project Team
March/July 2012	Use of Management Information in the planning of bus services	TPM Traffic Manager (1) JICA Project Team (1)
May 2012	Traffic Speed Survey, Intersection Traffic Survey, and Parking Survey (*Traffic Survey*)	DMTT Maputo (8) JICA Project Team (2)
May 2012	Use of GPS in Traffic Surveys (*Traffic Survey*)	DMTT Maputo (5) JICA Project Team (2)
June 2012	Fundamentals of Household Interview Surveys (HIS) in Urban Transport Planning *(Demand Analysis*)	DMTT Maputo (9) JICA Project Team (3)
June 2012	Demand Analysis and JICA STRADA software (Demand Analysis)	DMTT Maputo (2) JICA Project Team (2)
June 2012	HIS Questionnaire Forms (*Demand Analysis*)	DMTT Maputo (4) JICA Project Team (2)
July 2012	Reversible Lanes: Surveys and Design (*Traffic Management and Safety*)	DMTT Maputo (2) JICA Project Team (2)
July 2012	Preliminary meeting for the joint-working group meeting for urban planning, environment and socio-economic	DGIA-CMM (1) JICA Project Team
August 2012	Preliminary meeting for the 2nd environmental working group meeting	DGIA-CMM (1) JICA Project Team
November 2012	Details of steps involved in demand forecasting process and the use of traffic survey results	DMTT Maputo (4) JICA Project Team (2)
November 2012	Preliminary meeting for the 2nd joint-working group meeting for urban planning and environment	DGIA-CMM (1) JICA Project Team

Source: JICA Project Team.

Technical Report J

Strategic Environmental Assessment on Comprehensive Urban Transport Master Plan for the Greater Maputo

Contents

Figures

Tables

Technical Report J Strategic Environmental Assessment on Comprehensive Urban Transport Master Plan for the Greater Maputo

J.1 Legal Framework

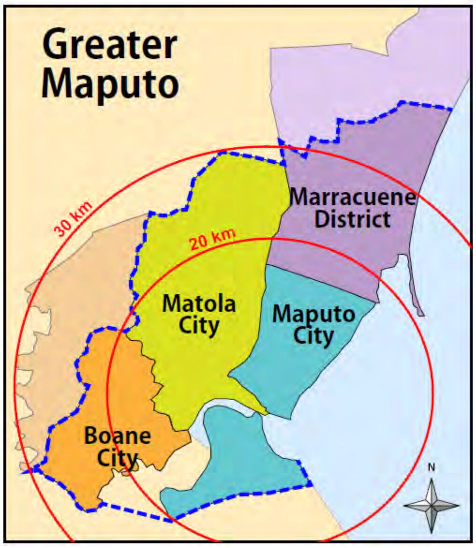
The Environmental Impact Assessment Process is regulated by Decree No.45/2004 (as amended by Decree No. 42/2008 of 4 November) in Mozambique. However, currently there is no legal requirement for SEA in Mozambique. On the other hand, it is required by JICA's Guidelines for Environmental and Social Considerations (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[1]. Therefore, the SEA in this section was conducted following the JICA Guidelines.

J.2 Study Area

The study area to be examined will be "Greater Maputo", as shown in Figure J.1. The area includes the following:

a. Whole of Maputo City (except for Inhaca Island)
b. Whole of Matola City
c. Southern Area south of Marracuene District
d. Eastern Area east of Boane City

The areas above have strong economic linkages. Central Maputo has offices and commercial buildings, and in Matola, there are the manufacturing industries. Maputo and Matola as well as surrounding areas absorb most of the labor force. As well, there are universities, vocational schools, and secondary schools concentrated in Maputo, thus many students also commute in. With such commuting patterns, it is prudent to formulate an urban transport master plan that considers the abovementioned areas as one metropolitan entity.



Source: JICA Project Team

Figure J.1: The Study Area

[1] Guidelines for Environmental and Social Considerations (April 2010)

J.3 Natural Conditions

J.3.1 Topography

Topographic morphology of Greater Maputo area has been classified into five types as follows:

(1) Lowland (Elevation of Lower than 10 m Sea Level)

Lowland spreads along the coastal area of Greater Maputo, including Maputo Bay in the south. It lies up to about 5km inland from the shore and flood susceptible areas are determined where two major rivers run through, namely Incomati River in Marracuene District that runs from the north and the other in Boane City where a river mouth for Matola River running from the north and Mafassane and Umbeluzi Rivers that run from the west into Maputo Bay.

(2) Low Terrace (Elevation between 11–30 m Above Sea Level)

Low terrace area in Greater Maputo tends to lie in inner land areas, mostly in Maputo City and part of Boane City.

(3) Medium Terrace (Elevation between 31–50 m Above Sea Level)

Medium terrace area concentrates in the northern part of Greater Maputo, covering northwest part of Maputo City, west part of Marracuene District and central part of Maputo City.

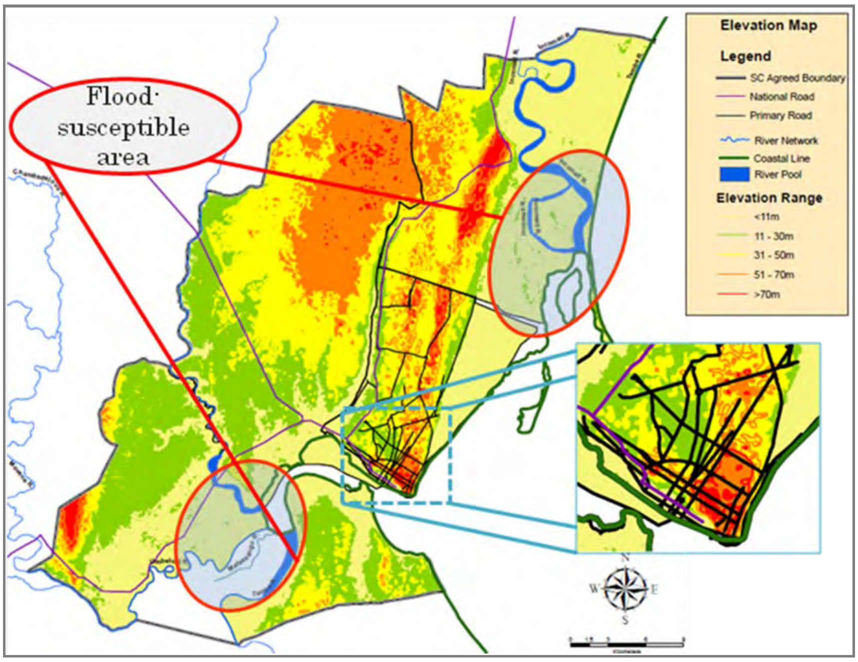
(4) High Terrace (Elevation between 51–70 m Above Sea Level)

There is a small amount of concentrated high terrace area in the Greater Maputo area, in Maputo City. Some high terrace areas are identified in Maputo City and Marracuene City (hilly areas), indicating quite steep slopes in such areas.

(5) Hill (Elevation More than 70 m Above Sea Level)

Major hills stretch across the centre of Maputo City up to southern part of Marracuene District. This stretch is recognized to be surrounded by medium terrace within a range of less than 1.5km, which could be interpreted that some areas may have cliffs. On the other hand, hills in north part of Matola City tend have gradual slopes and be surrounded by high terrace areas.

Figure J.2 shows a topographical map with the aforementioned classification. Two flood susceptible areas have been identified in the lowland area where major rivers run through.

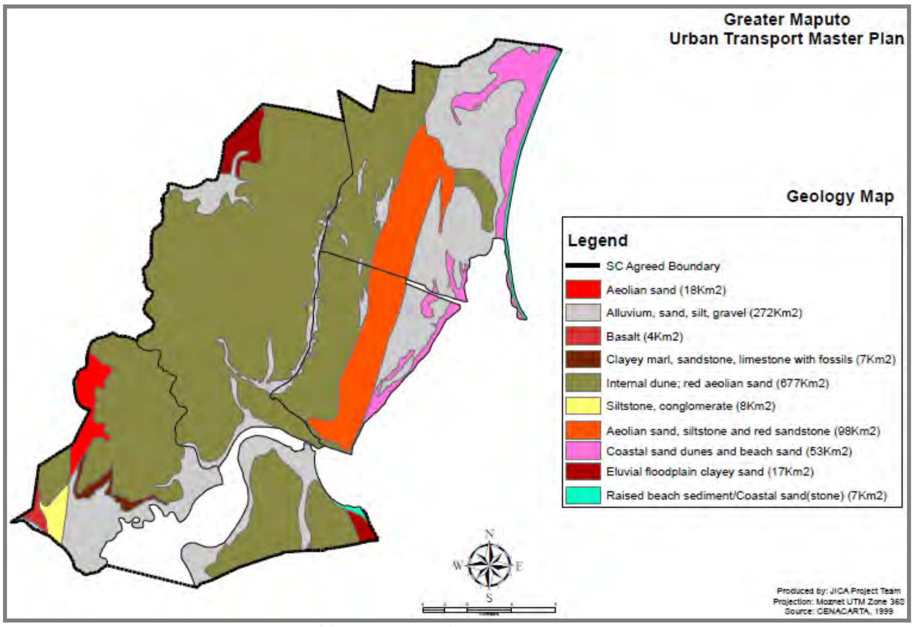


Source: Prepared by JICA Project Team (Based on ASTER DEM 90 m)

Figure J.2: Topographical Map

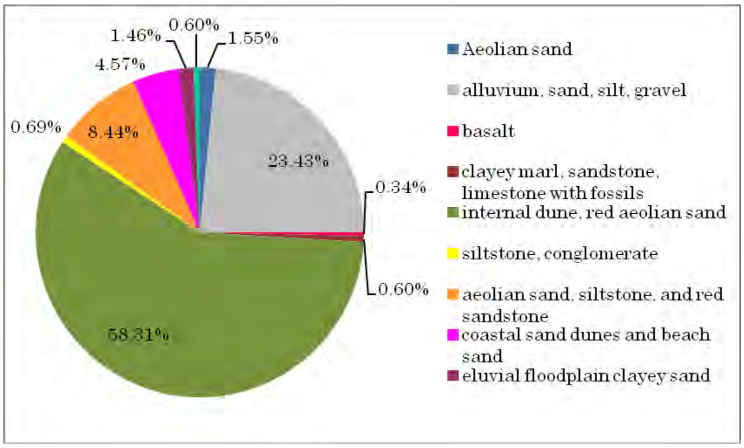
J.3.2 Geology

Having a relatively firm basement consisting of aeolian sand, siltstone and red sandstone, which runs through middle of Maputo City and Marracuene from the south to the north, the rest of Greater Maputo is covered mostly with internal dune, red aeolian sand, followed by mixture of alluvium, sand, silt and gravel covered-area in the coastal side where the elevation is below 10 m sea level, which covers 23% of the project area. High-elevated area (more than 70% above sea level) in Maputo City and Marracuene is covered by mixture of aeolian sand, siltstone and red sandstone.



Source: CENACARTA, prepared by JICA Project Team

Figure J.3: Geological Map



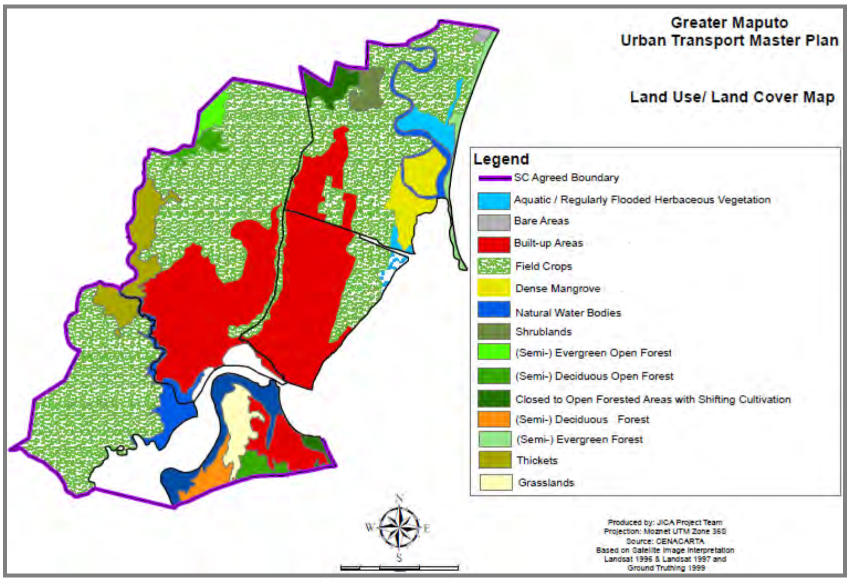
Source: CENACARTA, prepared by JICA Project Team

Figure J.4: Geological Proportion

J.3.3 Land Use

Figure J.5 summarises the existing land use in Greater Maputo, showing that most of Maputo City and about a half of Matola city are being used for human settlements while most of Boane and Marracuene district areas are being used for agricultural purposes. Approximately 4.5% of the total area (52 km^2), is identified as forests and none of the forest area is currently being designated as national park or protected areas. There are semi-evergreen open forests and semi-deciduous open forests, 0.7% and 1.67% of Greater Maputo respectively. These forest areas are recognized in Marracuene District, Matola City and Ka Tembe of Maputo City, all are located relatively far from the centre of Greater Maputo. Approximately 2.7% of the total area (32 km^2), is defined as dense mangrove that would require specific measures for compensation if any loss is anticipated by implementation of projects.

The data reflected in the GIS mapping shown in Figure J.5 was obtained from CENACARTA based on satellite image interpretation from Landsat 1996 and 1997, together with site visit in 1999.



Source: CENACARTA, prepared by JICA Project Team

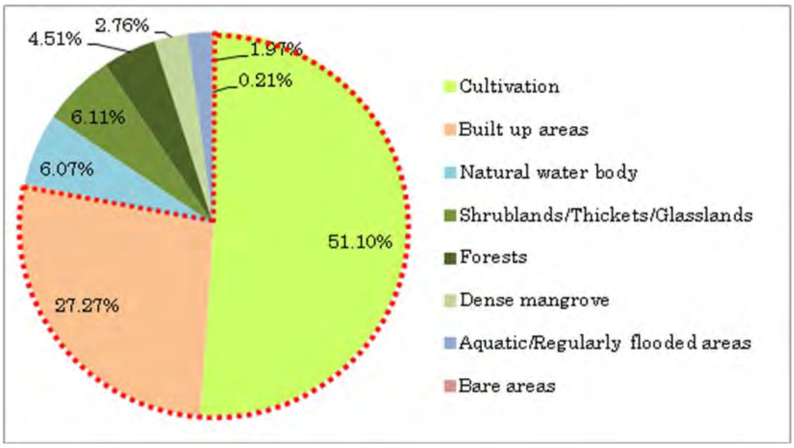
Figure J.5: Land Use

Below Table J.1 shows a breakdown of land use and by proportioning uses across the districts, more than 78% of the Greater Maputo area is being used by human needs as shown in Figure J.6.

Table J.1: Breakdown of Land Use

Land Use Cover Class	Boane	Maputo	Marracuene	Matola	total	%
Aquatic/Regularly Flooded Herbaceous vegetaion	0	5	17	0	23	1.97%
Bare Areas	0	0	2	0	2	0.21%
Built Up Areas	0	141	35	136	313	27.27%
Field Crops	166	36	166	198	566	49.39%
Dense Mangrove	0	0	32	0	32	2.76%
Natural Water Bodies	19	28	15	8	70	6.07%
Shrublands	0	0	11	0	11	0.97%
Semi Evergreen Open Forest	0	0	0	8	8	0.72%
Semi Deciduos Open Forest	0	10	0	9	19	1.67%
Closed to Open Forest Areas with shift Cultivation	0	4	15	1	20	1.71%
Semi Deciduos Forest	0	13	0	0	13	1.17%
Semi Evergreen Forest	0	0	11	0	11	0.94%
Thickets	12	0	0	27	39	3.36%
Grasslands	0	20	0	0	20	1.78%
Grand Total (km^2)	198	258	304	387	1,147	100%

Source: SENACARTA, 1999 (Prepared by JICA Project Team)



Source: SENACARTA, 1999 (Prepared by JICA Project Team)

Figure J.6: Proportion of Land Use

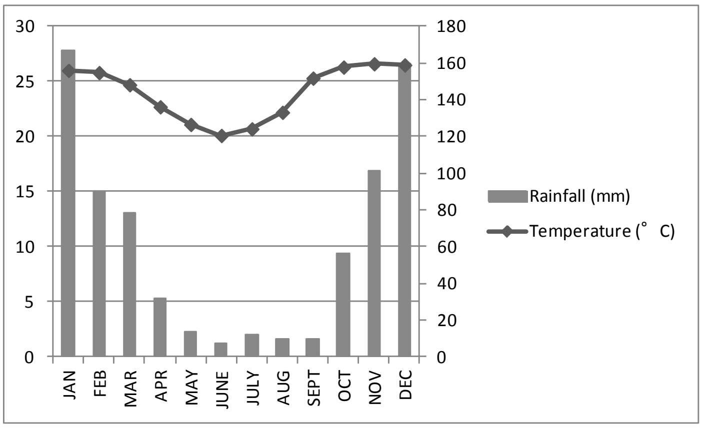
J.3.4 Climate

(1) Mozambique

Located on the eastern coast of southern Africa at 11°–26° south of the equator, Mozambique has a tropical to sub-tropical climate which is moderated by the influence of the mountainous topography in the north-west of the country. Seasonal variations in temperature are around 5° between the coolest months (June, July and August) and the warmest months (December, January and February). Geographically, temperatures are warmer near to the coast, and in the southern, lowland regions compared with the inland regions of higher elevation. Average temperatures in these lowland parts of the country are around 25°C–27°C in the summer and 20°C–25°C in winter. The inland and higher altitude northern regions of Mozambique experience cooler average temperatures of 20°C–25°C in the summer, and 15°C–20°C in winter.[2]

[2] UNDP Climate Change Country Profile, Mozambique

The rainy season in Mozambique starts from November and ends in April, with an average monthly rainfall from 1990 to 2009 of 104.68 mm in rainy season and 9.73 mm in dry season.[3] However, there is significant difference in the rainfall during rainy season in the north and south of the country, with 50–150 mm of rainfall per month in the southern part of the country and nearly twice the volume of rain, i.e. 150–300 mm, in the north.[4]



Source: The World Bank, Climate Change Knowledge Portal

Figure J.7: Average Rainfall and Temperature in Mozambique (1990–2009) [5]

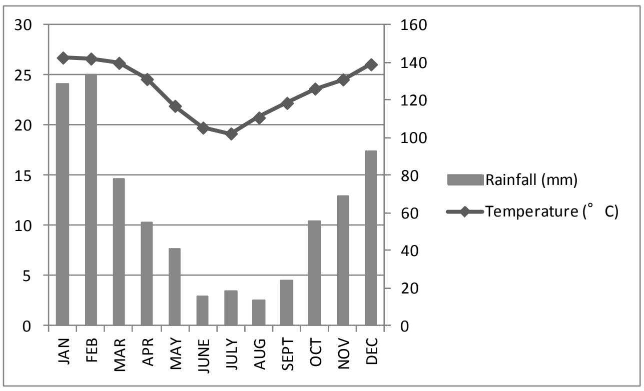
Table J.2: Average Rainfall and Temperature in Mozambique (1990–2009)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Temperature (°C)	26	25.8	24.7	22.7	21.1	20.1	20.7	22.2	25.3	26.3	26.6	26.5
Rainfall (mm)	166.8	90	78.6	31.7	14	7.3	12.3	9.6	10.2	56.5	101.3	159.7

Source: The World Bank, Climate Change Knowledge Portal

(2) Greater Maputo Area

The average temperature measured for Maputo City from 1990–2009 is show in Figure J.8 and its average temperature in summer is 26.49°C while it is 19.91°C in winter[6].



Source: The World Bank, Climate Change Knowledge Portal

Figure J.8: Average Rainfall and Temperature in Maputo (1990–2009) [7]

[3] The World Bank Group, Climate Change Knowledge Portal (http://sdwebx/worldbank.org/climateportal/index.cfm)
[4] UNDP Climate Change Country Profile, Mozambique
[5] The World Bank Group, Climate Change Knowledge Portal (http://sdwebx/worldbank.org/climateportal/index.cfm)
[6] The World Bank Group, Climate Change Knowledge Portal (http://sdwebx/worldbank.org/climateportal/index.cfm)

Table J.3: Average Rainfall and Temperature in Maputo (1990–2009)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Temperature (°C)	26.75	26.65	26.22	24.61	21.94	19.77	19.19	20.77	22.23	23.66	24.57	26.08
Rainfall (mm)	128.35	133.38	78.06	54.81	40.74	15.91	18.65	13.8	23.83	55.41	68.83	92.94

Source: The World Bank, Climate Change Knowledge Portal

J.3.5 Weather Conditions

Topographical conditions provide variations of rainfalls and Mozambique's coastal location lies in the path of highly destructive hurricanes and cyclones that occur during rainy season, namely El Niño. Central and southern parts of Mozambique receive more severe natural disasters. In recent years, there were 800 casualties in the year 2000 due to flood in the south part of Mozambique. In addition to floods, droughts is also one of the most influential disasters, affecting 600,000 people in 2002, 1.4 million in 2005, and 520,000 in 2007.[8]

J.3.6 Rivers in Greater Maputo Area

Six rivers run through the Greater Maputo area as shown in Figure J.9. There are three major rivers, namely Incomati River, Maputo River and Umbeluzi River. All these major rivers originate in neighbouring countries, such as Incomati River drains some 45,876 km^2 and comes from South Africa, Maputo River, with a catchment area of 29,800 km^2, flows from Natal in South Africa and Umbeluzi River, with a catchment of 5,622 km^2 flows into Mozambique from Swaziland.[9] As water management upstream of these rivers is critical, there is a Inco–Maputo Tripartite Permanent Technical Committee among these three countries for management of the water flow of these rivers specifically during times of drought and flood.

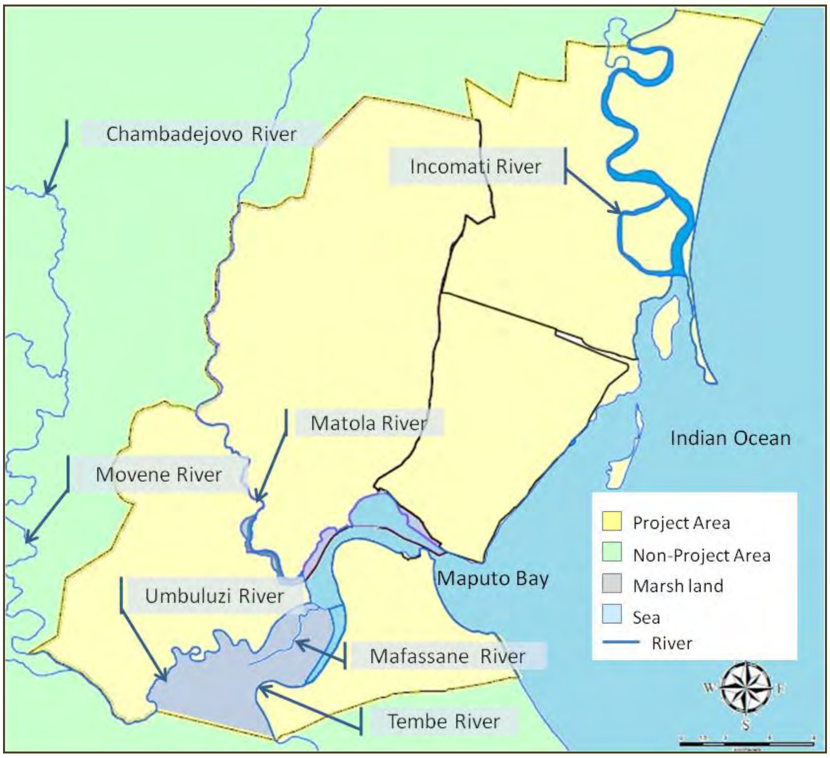


Figure J.9: River Network in Greater Maputo Area

7 The World Bank Group, Climate Change Knowledge Portal (http://sdwebx/worldbank.org/climateportal/index.cfm)
8 EM-DAT, the International Disaster Database
9 European Commission, Country Environmental Profile for Mozambique (2006)

J.3.7 Coastal Conditions

Along the west coast of Greater Maputo Area is the low-lying wetland covered by mangroves. This wetland performs important ecological functions such as drainage, rainwater reception, and dissipation. Acknowledging its ecological importance, the Municipality of Maputo made a decision in October 2012 to protect this area and develop as a natural park. The planned area for protection is shown in Figure J.10.

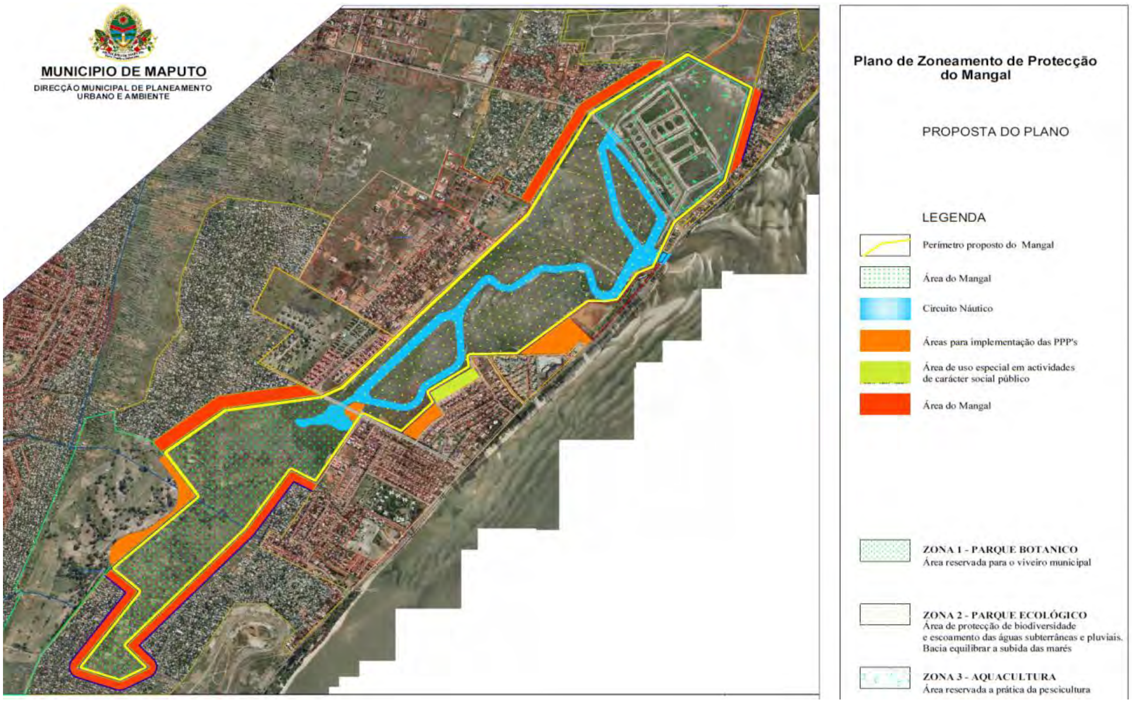


Figure J.10: Costa do Sol Mangrove Conservation Area

J.4 Socioeconomic Conditions

J.4.1 Population

Maputo comprised around 5.2% of the total population of Mozambique in 2010 (Table J.4). Although Maputo is the largest city in Mozambique, its percentage share in the total population declined by 0.2% between 2007 and 2010. The population density in Maputo is calculated at 3,873 people/km^2, which is much higher than the national average of 28 people/km^2 and the average in Maputo Province (53 people/km^2). Compared to the Census 1997, the population in Maputo increased at the average annual growth rate of 1.03% (Table J.5).

Table J.4: Population and Population Density in Mozambique in 2007 and 2010

Province/Region	Population in 2007		Population in 2010*			
	Population	Percent Structure (%)	Population	Percent Structure (%)	Area (km^2)	Population density / km^2
Mozambique	20,252,223	100	22,416,881	100.0	799,380	28
Urban	6,151,974	30.4				
Rural	14,100,249	69.6				
Niassa	1,170,783	5.8	1,360,645	6.1	129,056	11
Cabo Delgado	1,606,568	7.9	1,731,200	7.7	82,625	21
Nampula	3,985,613	19.7	4,414,144	19.7	81,606	54
Zambezia	3,849,455	19.0	4,213,115	18.8	105,008	40
Tete	1,783,967	8.8	2,050,242	9.1	100,724	20
Manica	1,412,248	7.0	1,610,728	7.2	61,661	26
Sofala	1,642,920	8.1	1,812,881	8.1	68,018	27
Inhambane	1,271,818	6.3	1,377,908	6.1	68,615	20
Gaza	1,228,514	6.1	1,298,651	5.8	75,709	17
Maputo Province	1,205,709	6.0	1,385,604	6.2	26,058	53
Matola City	671,556	3.3	766,069	3.4	368	2,079
Boane	102,555	0.5	121,538	0.5	820	148
Marracuene	84,975	0.4	105,012	0.5	666	158
Maputo City	1,094,628	5.4	1,161,833	5.2	300	3,873

Source: INE, Statistical Yearbook 2010, Census 2007.
Note: *projected population by INE.

Maputo consists of seven Municipality Districts, including KaTembe and KaNyakal (the Inhaca Island). Below the Municipality District, there are around 10 bairros, headed by a Bairro Secretary. Table J.5 shows a summary of the population in the study are.

Table J.5: Summary of Population in the Stufy Area in 1997 and 2007

City, District, DM, Post Administration	1997 Census	2007 Census					Population Growth 97/07
	Population	Population	Male	Female	Area* (km^2)	Population Density	
Maputo	966,837	1,094,628	532,570	562,058	316	3,464	1.0%
Kampfumu (DM1)	133,759	108,096	52,963	55,133	13.5	8,007	−2.1%
Nhlamankulu (DM2)	162,750	154,272	75,906	78,366	8.8	18,587	−0.5%
KaMaxakeni (DM3)	210,551	223,628	109,940	113,688	12.2	18,330	0.6%
KaMavota (DM4)	228,244	293,270	141,654	151,616	76.9	3,814	2.5%
KaMubukwana (DM5)	211,008	290,775	140,315	150,460	59.8	4,862	3.3%
Ka Tembe		19,371	9,325	10,046	104.7	185	2.0%
Matola	424,662	671,556	323,819	347,737	341.9	1,964	4.7%
Infulene	125,341	227,048	109,118	117,930	159.4	1,424	6.1%
Machava	118,234	225,429	108,330	117,099	121	1,862	6.7%
Matola	175,873	219,079	106,371	112,708	61.4	3,567	2.2%
Marracuene	41,677	84,975	40,849	44,126	666	128	7.4%
Boane	56,703	102,555	49,258	53,297	820	125	6.1%

Sources: INE, Census 1997, Census 2007, PEUCM 2010, PEUMM 2008
Note: Official area data in Maputo and Matola are not available at the time of writing and subject to change accordingly.

In Kampfumu (DM1), the number of population decreased by 25,663 between 1997 and 2007. In particular, the population in Malhangalene A and Polana Cimento B declined at the annual rate of −4.5% and −4.1% respectively. It can be partly explained by part of the population migrating to the suburbs in Maputo or the peri-urban city of Matola. In addition, increased commercial activities in this area may have replaced the residential area in KaMapfumu. The average population density in this district is 8,007 people/km^2, which implies that this area is highly populated. This district is regarded as "consolidated area", with permanent structured buildings and more or less completed infrastructure services.

The trend of decreasing population is also seen in Nhamankulu administrative district (DM2), but with less declining rate (−0.5%). This district is highly populated, as the population density stands at 17,531 people/km^2, which is around 5 times the average in Maputo, or 626 times more than the national average. The highest population density in Maputo is identified in KaMaxakeni (DM3), with the population density of 18,330 people/km^2. This area is growing at the moderate population growth rate of 0.6% between 1997 and 2007.

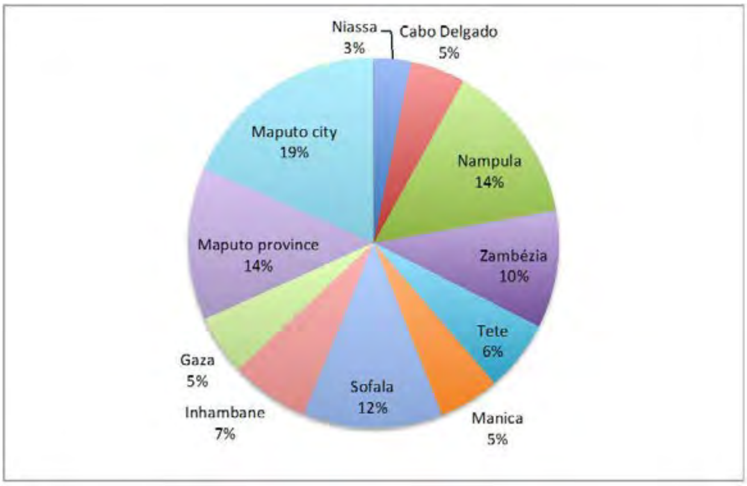
The largest population in Maputo is located in KaMavota (DM4), where 293,270 people were registered in the Census of 2007. The population growth in Albazine bairro is significant, in which the population increased from 5,152 in 1997 to 15,985 in 2007. DM4 is the largest area in Maputo (76.9 km^2) and relatively less populated with the density of 3,814. KaMabukwana (DM5) has the highest population growth rate of an administrative district in Maputo, with a growth rate of 3.3% between 1997 and 2007. This increase is mostly attributed to the growth in Zimpeto and Magoanine bairros at the growth rate of 8.2% and 9.0% respectively.

Matola City is the second largest city in Mozambique, totalling 766,069 people in 2010 (Table J.4). The density of population in Matola is estimated at 1,964 people/km^2, which is high compared to the average population density in Maputo Province (53 people/km^2). The population in the Matola City has been growing at the growth rate of 4.46% between 1997 and 2007 (Table J.5). It is considered that this increased urbanization in Matola mainly resulted from the migration from Maputo to the suburban area in Matola, and the rural-urban migration within the Maputo Province or from other Southern Provinces. The most growing post administration is seen in Machava, with the growth rate of 6.7% between 1997 and 2007.

Boane and Marracuene are the surrounding districts of the Maputo Municipality. The population in these districts almost doubled between 1997 and 2007, as shown in Table J.5. In this decade, the growth rate of Boane and Marracuene is recorded at 6.1% and 7.3% respectively, which is very high compared to those of Maputo City (1.0%) and Maputo Province (3.8%). However, the population density is much lower than in Maputo and Matola, which is estimated to be 125 people/km^2 in Boane and 128 people/km^2 in Marracuene. These districts have been growing rapidly, in particular along the main roads to the city centre in Maputo. For instance, Matola Rio post administration has increased its population rapidly, with basic infrastructure services such as transport and electricity and the proximity to the Beluluane Industrial Park and the EN4.

J.4.2 Economy

The Maputo Municipality is the largest regional economy in Mozambique, comprising of 19% of the national GDP, followed by Maputo Province (Figure J.11). Both Maputo City and Maputo Province demonstrated a steady growth of Gross Regional Domestic Product (GRDP) over the last decade, as shown in the historical evolution of GRDP in Table J.6. The average growth in Maputo between 2001 and 2009 was 7.5%, which is slightly lower than the national average (8.2%). Meanwhile, Maputo Province performed with a higher growth rate of 8.5% in the same period, although there was more adverse impacts from the global economic crisis in 2007 and 2009 when the growth rate recorded at 5.3% and 5.9% respectively. This may be partly due to the decline of exports in aluminum smelter Mozal in the Beluluane Industrial Park in Boane during the global economic crisis.



Source: Data from INE

Figure J.11: Gross Regional Domestic Product (GRDP) in 2009 by Province: Constant Prince in 2003 (in Percent of the National GDP)

Table J.6: GDP and GRDP Growth Rates by Province between 2001 and 2009

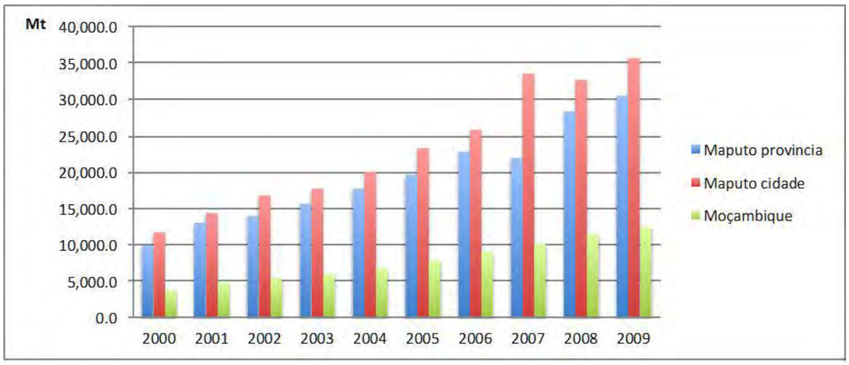
	GDP Growth Rate (%)								
Region/Province	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Niassa	13.7	13.4	8.8	6.9	8.5	7.7	7.3	6.2	7.1
Cabo Delgado	12.7	11.5	9.8	7.7	7.6	10.5	4.5	6.7	6.8
Nampula	10.2	7.1	5.4	5.9	7.7	9.3	9.2	8.3	6.4
Zambézia	11.8	9.9	6.4	6.4	8.9	9.4	8.0	6.8	6.4
Tete	10.6	11.8	9.3	10.0	11.4	12.0	7.6	−1.0	8.0
Manica	12.5	11.2	6.2	7.4	6.4	9.9	6.8	7.5	6.7
Sofala	12.7	8.9	6.4	7.4	8.7	8.6	7.5	7.5	6.6
Inhambane	10.6	10.1	5.7	13.6	8.4	11.3	8.9	7.3	6.6
Gaza	12.0	9.5	5.7	6.6	6.4	8.5	9.2	8.2	6.3
Maputo province	17.7	9.3	9.0	8.2	6.6	7.2	5.3	7.1	5.9
Maputo city	10.8	7.7	4.0	8.4	10.1	6.4	6.4	7.4	6.1
Moçambique	**12.3**	**9.2**	**6.5**	**7.9**	**8.4**	**8.7**	**7.3**	**6.8**	**6.4**

Source: Data from INE

As the real sector has been growing, the average income of Mozambican people has increased significantly. The average GDP per capita in Mozambique increased from 3,807 MT (equivalent to USD 251) in 2000 to 12,616 MT (equivalent to USD 454) in 2009 (Figure J.12). The GDP per capita in Maputo City and Maputo Province are highest in Mozambique (Figure J.13). At the current price, GDP per capita in Maputo City and Maputo Province in 2009 stand at 35,735MT (USD 1,285) and 30,479 MT (USD 1,079) respectively, which are around 3 times more than the national average.

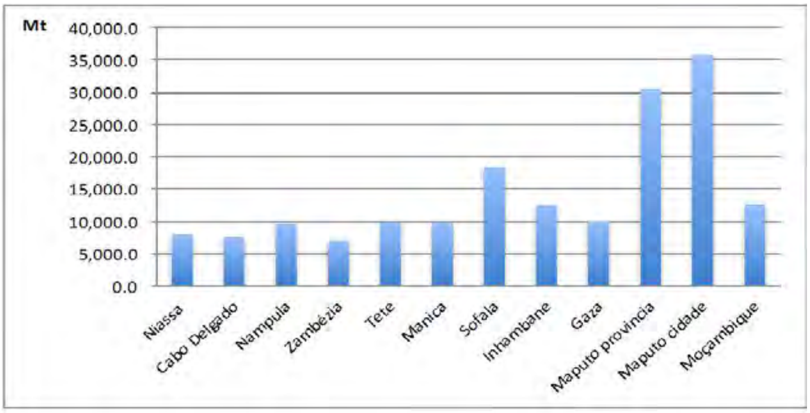
However, the driving force of growth in Mozambique mainly results from the large foreign investments such as Mozal while the development of small and medium enterprises (SMEs) has been relatively far behind. For instance, the number of SMEs in 2002 was registered at 28,474, which was very low considering the percentage of population in Mozambique (around 0.15% of the total population). In addition, it is importantly stated that around 60% of economic activities in Greater Maputo are informal, with a fragile return from their economic activities.

Nonetheless, these economic performance indicators show that Greater Maputo is the largest and the most active in economy in this country.



Source: Data from INE

Figure J.12: Increase of GDP per Capita by Province between 2000 and 2009 (Current Price, MT)



Source: Data from INE

Figure J.13: GRDP per Capita by Province in 2009 (Current Price, MT)

J.4.3 Industry

Maputo is the largest commercial city in Mozambique. The Municipality also serves as a gateway to the Indian Ocean for the southern region of Mozambique and the landlocked neighbouring countries such as South Africa and Swaziland. The Census of Enterprises (CEMPRE) in 2002 showed that 28% of enterprises (8,085 enterprises) in Mozambique were located in the Maputo Municipality. The number of workers in Maputo accounted for 141,009 in 2002, which means that 47% of the total working population in Mozambique were employed in Maputo. Although the percentage of large enterprises in Mozambique has been very small (1.4% of the total enterprises), large enterprises accounted for 58 percent of the total volume of transaction. Table J.7 summarizes the number of enterprises, workers, and volume of sales in the Project Area in 2011.

Municipal District of KaMpfumu (DM1) is the most active district in commerce and industry in Maputo. In 2011, 3,079 enterprises were located in KaMpfumu (DM1), which accounts for 42% of the total enterprises in Maputo. As this district comprises of a larger scale of enterprises than other Municipal Districts, the number of workers operating in this District was much higher, comprising of 73% of the work force in Maputo. Most workers in this district have been engaged in financial activities and insurance (19,506), followed by commercial and automobile activities (16,854 workers), and hotel and restaurant (11,584 workers). In terms of the volume of sale, commercial activities and automobile repair was the most dominant, accounting for 54% of the total sale in this district.

Nhlamankulu (DM2) is the secondary largest commercial district in Maputo. The category of "Financial activities and insurance" accounts for 36% of workers in this district, followed by energy and water related industry (25%) and commercial and automobile repair industry. KaMubukwana (DM5) has a relatively higher number of enterprises (1,218) than Nhlamankulu (1,007), but due to the small scale of the economy, the transaction volume in this district is around half of Nhlamankulu. The "energy and water related industry" and "commercial and automobile industry" have been the main economic activities in DM5.

Around 80% of enterprises and workers in Greater Maputo are concentrated in the Maputo Municipality, followed by Matola (16%, 17%) and Boane city (3%, 4%). In terms of the volume of sale, Maputo accounts for 62% of the total project area, while the percentage of Matola and Boane have increased to 22% and 16% respectively.

It has been stated that around 50% of the active workforce in Maputo has been engaged in informal sectors. It was estimated that 225,000 people were involved in the informal employment such as street vending, small-scale productive activities, and domestic services in 2000 (Jenkins, 2000). This means that the actual commercial and industrial workforce in Maputo may be a double. The contribution of the informal economy to GRDP may be marginal compared to the formal sector, but their mobility from home to the work place, or from the collecting points to the vending place, may have an equally important impact on the transport system as that resulting from the formal one.

Table J.7: Summary of Enterprises, Workers, and Volume of Sales in the Project Area in 2011

Province/District/P. Administration/ Locality	No of Enterprises	No. of Workers	Volume of Sale (million MT)
Maputo City	**7,267**	**111,096**	**156,916**
KaMpfumu (DM1)	3,079	80,757	131,350
Nhlamankulu (DM2)	1,007	13,960	12,257
KaMazakeni (DM3)	847	6,673	5,972
KaMavota (DM4)	1,045	3,872	1,043
KaMubukwana (DM5)	1,218	5,624	6,280
KaTembe	71	210	14
Maputo Province	**1,994**	**27,949**	**98,092**
Boane City	**306**	**5,279**	**41,042**
Locality of Vila de Boane	140	1,918	786
Locality of GueGueGue	22	97	4
Locality of Eduardo Mondlane	12	92	1
Locality of Matola Rio	132	3,172	40,251
District of Marracuene	**113**	**518**	**36**
Locality of Vila de Marracuene	44	136	5
Locality of Marracuene – sede	63	360	29
Locality of Nhamgonhane	6	22	2
Matola City	**1,575**	**22,152**	**57,014**
Post Administration of Infulene - sede	339	1,087	13,231
Post Administration of Machava	363	4,643	6,925
Post Administration of Matola City	873	16,422	36,859
TOTAL	**9,261**	**139,045**	**255,008**

Source: Data from INE

Note: Data includes the following industries classified by CAE (Classification of Economic Activities): A) Agriculture, Livestock, Hunting, Forest, and Fishery; B) Extractive Industry; C) Transformed Industries; D) Electricity, Gas, Steam, Hot and Cold Water, and Cold Air; E) Intake, Treatment, and Distribution of Water, Sewage, Management of Residues and Pollution; F) Construction; G) Gross and Retail Commerce, Repair of Automobile Vehicles, Motorcycles; H) Transport and Storage; I) Hotel and Restaurant; J) Information and Communication Activities; K) Financial Activities and Insurance. This classification is different from the results of CEMPRE 2002, which added the classification of M) education, N) health, and O) other activities.

The Matola City and Boane include the major industrial parks and commercial activities in Mozambique. Mega-Projects such as the Beluluane Industrial Park, Texlom (cotton company), and Maputo Port have been located in this area. Due to the proximity to Maputo Port and the Maputo Corridor, most large industries and storage facilities have been concentrated in the post administration Matola City or the Beluluane Industrial Park in Boane. The transformed industry accounts for 36% of workers in Matola, followed by construction (28%), and commercial and automobile activities (19%).

In Boane, transformed industry consists of 48% of the total work force and 98% of the total volume of transaction. This increase in the sale's volume results from the aluminum smelter factory of Mozal, a largest company in Mozambique, situated in the Beluluane Industrial Park in Matola Rio. The Matola and Boane area passes through the Maputo Corridor (EN4) linking Maputo and South Africa, and various industrial activities such as the construction of industrial parks, electricity development, and agro-processing factories have been developing. For instance, a new industrial park will be constructed in bairro Matola–Gare along the planned new road connecting EN1 and EN4. In this park, 46 ha has been secured by Matola Municipality, of which 20ha has been given to the multinational company, Coca Cola. Another example the cotton factory, Texlom, which employs around 1,200 workers and is situated in Bairro Mussubuluco in Matola.

J.5 SEA Considerations on the Greater Maputo Transport Master Plan

J.5.1 SEA Considerations on Future Development Vision

In this study, SEA considerations were applied in two stages. The first stage was development of future vision and the second stage was alternative transport development scenarios.

Three potential urban development vision statements were developed as follows.

Vision 1: Greater Maputo: *"The City Bridging the Old and New"*
Vision 2: Greater Maputo as a "*Socially and Environmentally Sustainable International Gateway Capital*"
Vision 3: Greater Maputo as a "*Dynamic and Vibrant Capital of Mozambique*"

In order to select the best vision in which overall environmental and social benefits are maximized, these statements were evaluated and compared in terms of the following viewpoints covering the environmental and social aspects. These evaluation criteria were discussed in the working group meetings.

- Area-wide assessment
- Economic impacts
- Social impacts
- Environmental impacts
- Public involvement

The results of the evaluation are summarized in Table J.8. Vision 2 marked the highest score and therefore was selected as the development vision of the Greater Maputo Area.

Table J.8: Examination of Urban Development Visions by SEA

Impacts	Details	Vision 1	Vision 2	Vision 3
Area - wide	The vision considers overall Greater Maputo area	✓	✓	✓
	The vision considers not only Greater Maputo and other surrounding areas			✓
Economic	The vision includes economic perspectives		✓	✓
Social	The vision implies benefit for all citizens, including vulnerable people		✓	
	The vision encourages preservation of cultural heritage	✓	✓	
	The vision attempts to avoid or minimize negative social impacts caused by urban development		✓	
Environmental	The vision envisages improvement of city landscape	✓	✓	✓
	The vision considers sustainable development of Greater Maputo	✓	✓	✓
	The vision attempts to minimize negative environmental impacts caused by urban development		✓	
Qualitative assessment (total number of ticks)		**4**	**8**	**5**

Source: JICA Project Team

J.5.2 SEA Considerations on the Transport Development Scenarios

For the transport development scenarios, again three alternative scenarios were developed and compared in order to select the one which can minimize negative impacts on the environment and society.

The 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.

<u>Resettlement</u>

For each scenario, proposed road/BRT/rail network was overlaid on Google Earth images, and the number of buildings that would need to be removed was counted.

<u>Flora & Fauna</u>

For each scenario, proposed road/BRT/rail network was overlaid on Google Earth images. Each road/BRT/rail was evaluated on the scale of 1 to 5 as follows.

1: The proposed route falls on the forest.
2: More than half of the proposed route falls on the forest.
3: More than one-third of the proposed route falls on the forest
4: Some trees need to be removed including street trees
5: No tree/vegetation in the proposed route

Finally, an average of the scores for each route was calculated for each scenario.

<u>Flood Susceptibility</u>

For each scenario, proposed road/BRT/rail network was overlaid on Google Earth images. Each road/BRT/rail was evaluated on the scale of 1 to 5 as follows.

1: High probability of flooding
2: Relatively high probability of flooding
3: Intermediate probability of flooding
4: Some probability of flooding
5: No probability of flooding

Finally, an average of the scores for each route was calculated for each scenario.

The results of the evaluation are summarized in Table J.9.

Table J.9: Examination of Transport Development Scenarios by SEA

	Scenario A	Scenario B	Scenario C	Notes
Air Pollution	1	3	5	Based on the demand modeling data
Global Warming (CO_2 emission)	1	3	5	Based on the demand modeling data
Resettlement (estimated number of buildings)	2 (2110)	1 (2641)	2 (2112)	Estimated from Google Earth images
Flora/fauna	4	4	4	Based on the estimated number of trees that will be cut down.
Flood Susceptibility	4	4	4	
Total	**12**	**15**	**20**	

Source: JICA Project Team

As a result of traffic demand modeling, daily NOx emission was estimated as 116 kg/day in 2035 for Scenario A, 51 kg/day for Scenario B, and 39 kg/day for Scenario C. Thus, Scenario B and C will result in 56% and 66% reduction of NOx emission respectively.

Likewise, daily CO_2 emission was estimated as 45,113 kg/day in 2035 for Scenario A, 21,115 kg/day for Scenario B, and 16,202 kg/day for Scenario C. Thus, Scenario B and C will result in 53% and 64% reduction of CO_2 emission respectively, which will significantly reduce global warming.

For involuntary resettlement, all of the scenarios were estimated to cause more than 2000 households of resettlement. Therefore, low scores were assigned for this criterion, but Scenario B had larger number of resettlement and was assumed to have the largest negative impact.

As for the impacts on flora/fauna and flood susceptibility, there were not significant differences among the scenarios. All 3 scenarios scored approximately 4 in these criteria.

Overall, Scenario C had the highest score. Therefore, it was concluded that Scenario C was the best transport development plan.

J.5.3 Potential Environmental and Social Impacts of the Master Plan

The potential Social/Environmental Impacts of this master plan that are identifiable at this stage are listed on Table J.10 and Table J.11. 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 by more detailed study, it is estimated to be more than 2,000 households. The involuntary resettlement at this large scale would require the preparation of Resettlement Action Plan (RAP) according to 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.

Table J.10: Potential Social/Environmental Impacts and Mitigation Measures for the Greater Maputo Urban Transport Master Plan (during Construction)

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.

No.	Check Items	Rating	Notes	Mitigation
Social Environment				
1	Involuntary resettlement	A	The master plan is expected to cause involuntary resettlement of more than 2,000 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.	

No.	Check Items	Rating	Notes	Mitigation
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.
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.	

Source: JICA Project Team

Table J.11: Potential Social/Environmental Impacts and Mitigation Measures for the Greater Maputo Urban Transport Master Plan (during Operation)

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.

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.	
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.	

No.	Check Items	Rating	Notes	Mitigation
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.	

Source: JICA Project Team

J.5.4 Public Consultation

In accordance with JICA's Guidelines for Environmental and Social Considerations (2010), implementation of public consultation meetings is required during the SEA process. A stakeholder meeting was held on 19 June 2013.

J.6 Related Activities

J.6.1 Environmental Working Group

The 3rd meeting for environmental working group was held on 13 February 2013 and the results of SEA were discussed. For the members who could not attend the meeting, separate interview sessions were held with the JICA Project Team. Below are some of the comments received from the working group members.

Arlando Sigauque, Department of Environmental Assessment, Municipality of Matola

- The master plan is good because it incorporates future population growth and land use projection.
- What will be the effects on employment after the temporary high demands for workers for all the construction works?

Raul Chilaue, Head, Depart of Environment, Municipality of Maputo

- Resettlement is a huge problem in Maputo. In other ongoing projects, resettlement is difficult because of shortage of budget and available land in Maputo City. For example, 800 households are required to resettle solely for Ka Tembe Bridge project.
- In October 2012, the municipality approved a plan for creating reserved area in the coastal mangrove zone.
- Also, 100 m area within the coastline is protected by law.

- The Maputo City is now implementing a study for ecological zoning plan. In order to avoid any conflicts of this master plan with the zoning plan, coordination is necessary. The consultants undertaking the ecological study should be invited to SHM.

Mr. Joao Cipriaaio, Chief of Department of Urban Environment, Coastal Zone Management Department, MICOA

- Because of the large scale of involuntary resettlement, there may be negative impacts on biodiversity by developing new residential areas.
- Is there any possibility of impacts on health and sanitation, such as HIV and Cholera?
- Drainage is important in order to prevent flooding.
- There are some socially protected commons in some communities (such as water reservoir and graveyards). Although these areas are not under official protection, conservation of these areas must be considered too.
- To prevent soil erosion, it is better to transplant street trees rather than just cutting them down.
- MICOA is now making SEA guideline, which will be applied to coastal area.

Fernando A. Tembe, Department of Infrastructure, Marracuene District
Cândida C. Teles, Department of Environment, Boane City

- There are some protected areas in Boane and Marracuene, but not in the project area.
- The demand (and price) for the land is rapidly growing because many people (especially young generation) are moving in from Maputo City.
- The location of planned new infrastructure must be informed early so the District can plan the land use accordingly.
- Some negative impacts on environment are already notable (such as deforestation) because of rapid influx of population.
- It is a very good idea to have a stakeholder meeting.
- For the Ring Road Project, there have been no EIA or RAP.

Technical Report K

Transport and Traffic Surveys: Methodology and Analysis

Contents

Figures

Tables

Technical Report K Transport and Traffic Surveys: Methodology and Analysis

K.1 Introduction

K.1.1 Overview

This Technical Report sets out the purpose of surveys, as well as describing those surveys undertaken, together with their results.

K.1.2 Purpose of Surveys

The surveys were designed and undertaken to collect data necessary for various tasks required in this study. Surveys are defined in general as being data collection exercises requiring research, in almost all cases fieldwork. Other documentary data, in both hard and soft formats, have been collected from appropriate stakeholders.

The role of surveys and their location in the project methodology are illustrated schematically in Figure K.1. Desktop data collection is defined as those data available in document form (hard or soft copy) from stakeholders, i.e. not requiring field work for collection.

Figure K.1 shows the envisaged workflow of surveys feeding into base year transport model development in more detail.

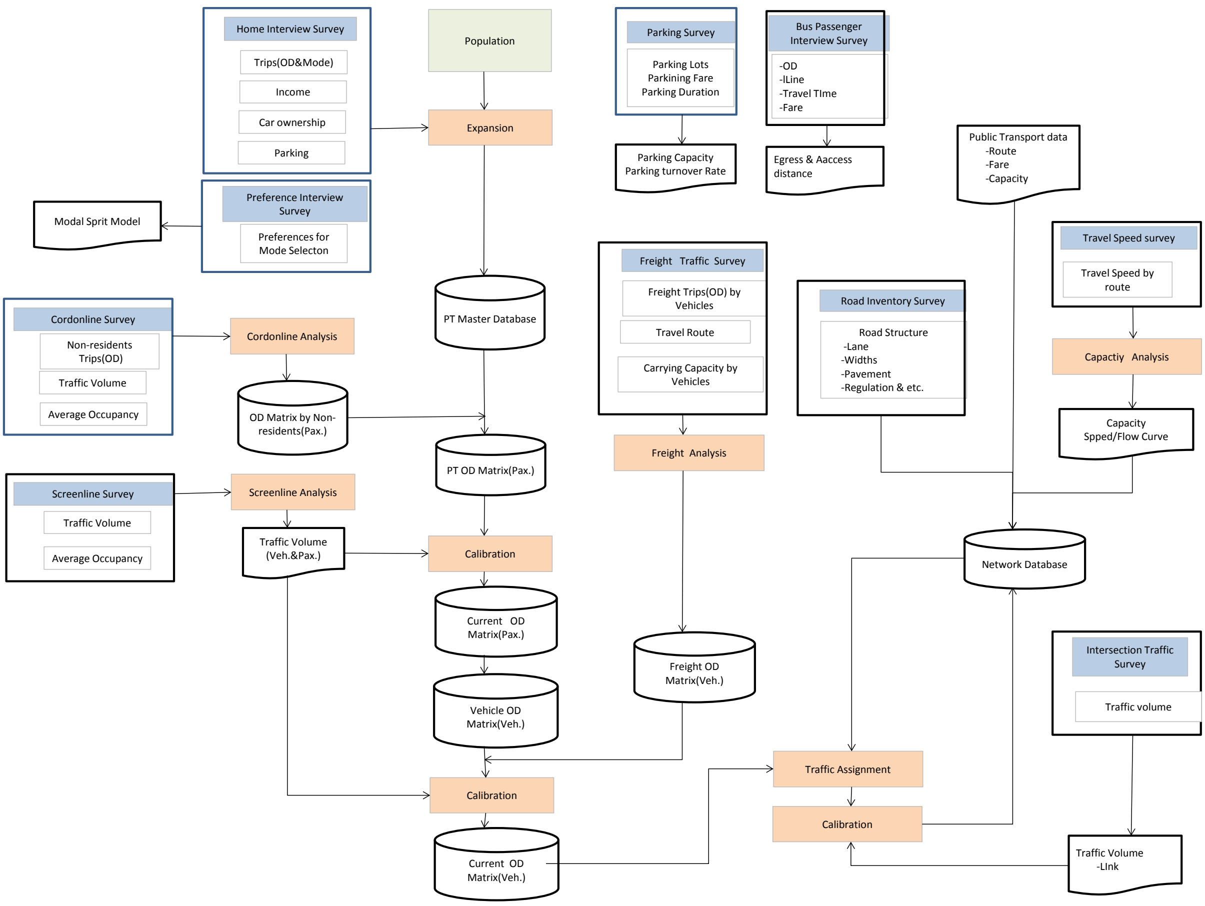


Figure K.1: Interrelationship between Surveys and Transport Model Development

K.1.3 Structure of this Technical Report

The remainder of this Technical Report is structured as follows:

- Section K.2 describes the Inventory Surveys
- Section K.3 describes the Household Interview Surveys (HIS)
- Section K.4 describes the Cordon and Surveys
- Section K.5 describes the Freight Surveys
- Section K.6 describes the Junction Surveys
- Section K.7 describes the Public Transport Surveys
- Section K.8 describes the Stated Preference Surveys

K.2 Inventory Surveys

K.2.1 Purpose and Objectives

Inventory Surveys were commissioned to collect data unavailable from desktop methods and to verify certain of the desktop data. Its objectives were as follows:

- Validate or enter, as appropriate, the road network topology of major roads, within the study area
- Collect and collate information on the standards and characteristics of these roads
- Identify locations of chapa and bus terminals
- Confirm bus and chapa routes
- Identify and map intersections and sketch all the method of control for all signalized intersections

Consequently, results from the Inventory Surveys informed the scoping and development of Terms of Reference for a number of other surveys.

K.2.2 Methodology

The methodology workflow for the Inventory Surveys is depicted in Figure K.2. The work programme developed is shown in Figure K.3.

Figure K.2: Workflow for Inventory Surveys

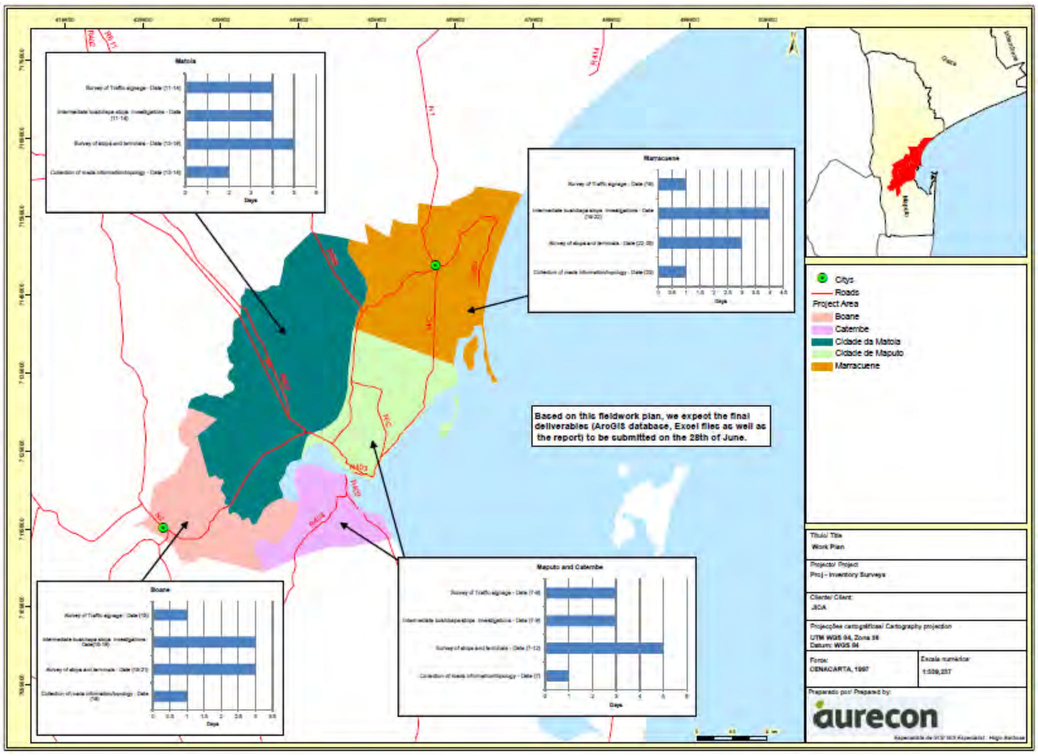


Figure K.3: Work Programme for Inventory Surveys by City/District

K.2.3 Outputs and Key Findings

Data collected were collated into an ArcGIS database. This database is described in more detail in Technical Report L.

The total surveyed road network covered 2,947 km of road. The breakdown by area within the Study Area is shown in Figure K.4.

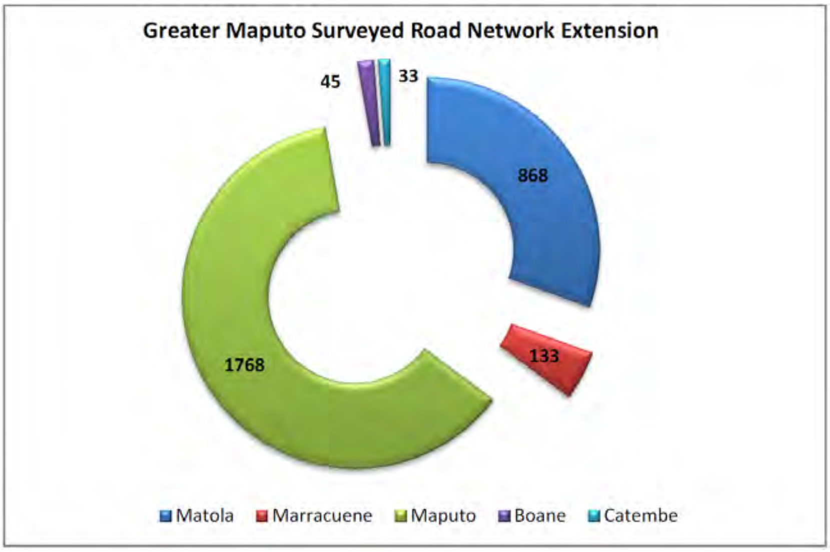


Figure K.4: Road Network Surveyed by Area

280 public transport routes were identified, distributed as shown in Figure K.5. A total of 55 terminals were identified, with chapas operating at all of them. Just under half of these terminals were used by buses. The distribution of these terminals is given in Table K.1.

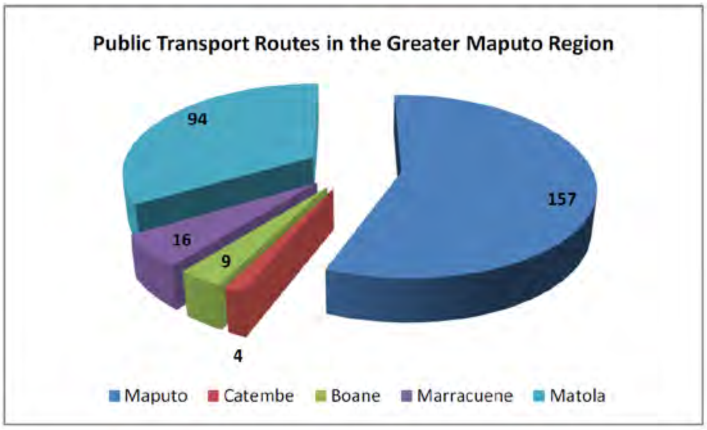


Figure K.5: Public Transport Routes in the Greater Maputo Region

Table K.1: Public Transport Terminals

Sub-Area	Terminals
Maputo	17
Marracuene	5
Boane	4
Catembe	3
Matola	26
Total	55

About 56% of the surveyed roads in Matola are paved. In Boane only about 26% is paved. In Maputo only about 10% of the surveyed network is unpaved. In Marracuene about 70% of the surveyed roads are unpaved.

K.3 Household Interview Survey

K.3.1 Purpose

The Household Interview Survey (hereinafter referred to as "HIS") is implemented in order to identify daily movements of individuals by purpose, time, and transport mode in the Greater Maputo region. The objective of this survey is to grasp all daily movements of individuals accurately.

K.3.2 Scope of Work

The scope of HIS can be summarized as follows:

- Establishment of Head Office for Survey Implementation: comprising the securement of the room for the implementation of the survey and the training of the surveyors
- Recruitment of Surveyors and Surveyors' Training: comprising the recruitment of sufficient number of surveyors and the practical training of these surveyors.
- Pilot survey: comprising the pilot survey for checking the appropriateness of the survey forms, and which also serves as a training tool for supervisors and surveyors.

- Preparation of Various Documents for HIS: comprising printing of the survey forms, example forms how to fill, survey manuals, zoning maps, etc.
- Implementation of Household Interview Survey: comprising the distribution, explanation how to fill, completion and in-field checking of survey forms, etc.
- Inspection and Editing of Completed Survey Forms: comprising the inspection and the editing of completed forms and ensuring that they have been properly and fully completed (this being an office-based function)
- Coding: comprising the coding of the origin and destination zones, railway stations and bus stops, etc.
- Data Input and System Data Check: comprising the data input of coded information into the computer, following the prescribed format and the input data error check by computer based on the prescribed system
- Basic Check Calculation: comprising the basic check calculation of the input data

K.3.3 Zoning, Sample Size and Sampling

(1) Study Area

The study area for HIS was the same as for the study as a whole.

(2) Sample Sizes – Total Sample and by City/District

Table K.2 gives the target sample size by city/district, which was calculated based on the populations of Maputo City (excluding Inhaca), Matola and those parts of Marracuene and Boane within the study area. These figures represent absolute minima of valid samples required.

Table K.2: Required Household Sample Size by City/District (Valid Samples)

	Sample Households
Mapto City	5,315
Matola City	3,989
Marracuene District	425
Boane City	271
Total	10,000

(3) Zoning: "A", "B" and "C" Zones within the Study Area

In accordance with JICA standard practice for conducting HIS, the study area was subdivided into the following zoning definitions:

- **"A" zones**: comprising the four cities/districts within the study Area
- **"B" zones**: comprising 40 zones within the study area used for sampling. Each "B" zone is contained wholly within one "A" zone.
- **"C" zones**: comprising 151 zones inside the study area, which for sampling complement the "B" zones, providing a finer level of detail; and which will be used in the transport modelling as internal study area zones. Each "C" zone is contained wholly within one "B" zone (and hence wholly within one "A" zone also)

Table K.3 and Table K.4 contain descriptions of the "B" and "C" zone definitions within the study area, respectively. The "B" and "C" zones are also shown in Figure K.6 (Maputo City), Figure K.7 (Maputo City Centre), Figure K.8 (Matola), Figure K.9 (Marracuene) and Figure K.10 (Boane).

Table K.3: Descriptions of "B" Zones within the Study Area

"B" Zone	City/ District	Administrative District	Locality/ Urban District	Bairros/ Aldeias
1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
2	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento B
3	Maputo City	DM KaMpfumu	Urban District 1	Central C
4	Maputo City	DM KaMpfumu	Urban District 1	Central A, Central B
5	Maputo City	DM KaMpfumu	Urban District 1	Alto Maé A, Alto Maé B
6	Maputo City	DM Nhlamankulu	Urban District 2	Malanga
7	Maputo City	DM KaMpfumu	Urban District 1	Coop, Sommershield
8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene A, Malhangalene B
9	Maputo City	DM KaMaxakeni	Urban District 3	Polana Caniço A, Polana Caniço B
10	Maputo City	DM KaMaxakeni	Urban District 3	Maxaquene A, Maxaquene B, Maxaquene C, Maxaquene D
11	Maputo City	DM Nhlamankulu, DM KaMaxakeni	Urban District 2, Urban District 3	Aeroporto A, Minkadjuine, Munhuana, Mafalala, Urbanização
12	Maputo City	DM Nhlamankulu	Urban District 2	Aeroporto B, Chamanculo A, Chamanculo B, Chamanculo C, Chamanculo D, Xipamanine
13	Maputo City	DM KaMubukwana	Urban District 5	Inhagoia B, Jardim, Luis Cabral
14	Maputo City	DM KaMavota	Urban District 4	Costa Do Sol
15	Maputo City	DM KaMavota	Urban District 4	3 De Fevereiro, Ferroviario, Laulane
16	Maputo City	DM KaMavota	Urban District 4	Fplm, Hulene A, Hulene B, Mavalane A, Mavalane B
17	Maputo City	DM Nhlamankulu	Urban District 3	Aeroporto
18	Maputo City	DM KaMubukwana	Urban District 5	25 De Junho A, 25 De Junho B, Bagamoio, George Dimitrov, Inhagoia A, Malhazine, Nsalene
19	Maputo City	DM KaMavota	Urban District 4	Albazine
20	Maputo City	DM KaMubukwana	Urban District 5	Magoanine A
21	Maputo City	DM KaMubukwana	Urban District 5	Zimpeto
22	Maputo City	Ka Tembe	Catembe	Chali, Chamissava, Guachene, Incassane, Inguide
23	Matola	Matola	Matola	Matola A
24	Matola	Matola	Matola	Trevo
25	Matola	Matola	Matola	Matola B, Matola C
26	Matola	Matola	Matola	Fomento, Matola F, Matola G
27	Matola	Matola	Matola	Matola D, Matola J, Mossumbuluku
28	Matola	Matola	Matola	Liberdade, Matola H
29	Matola	Machava	Machava	Machava A, Machava Central, Patrice Lumumba
30	Matola	Infulene	Infulene	Acordos De Lusaka, T-3, Unidade D, Vale Do Infulene
31	Matola	Machava, Matola	Machava, Matola	Tsalala, Cikuama, Malhampsane
32	Matola	Machava	Machava	Bunhica, S. Damanso, Singatela
33	Matola	Infulene	Infulene	1O Maio, Congolote, Ndlavela, Zona Verde
34	Matola	Machava	Machava	Matola Gare, Uamatibwana
35	Matola	Machava	Machava	Cobe, Km 15
36	Matola	Infulene, Machava	Infulene, Machava	Golhoza, Mucatine, Matlhemele
37	Matola	Infulene	Infulene	Boquisso, Intaca, Mali, Muhalaze
38	Marracuene	Marracuene	Vila de Marracuene, Marracuene Sede, Michafutene, Nhomgonhane	Massinga, Da Vila, 29 Setembro, Mikanhine, Mbuva, Macaneta 1, Hobjane, Mapulango, Zintava, Muntanhana(E), Macaneta 2, Faftine, Pussulana(E), Mali, Cumbeza (Povoado De Cumbeza), Agustinho Neto (Aldeia), Ricatla, Abel Jafar, Povoado De Guava, Momemo 4 De Outubro, Povoado De Momemo 15 De Agosto, Povoado De Mumemo 1, Aldeia Samora Machel
39	Boane	Matola Rio	Matola Rio	Chinonoquila, Belaluene (Povoacao De Beluluane), Jonasse (Povoacao De Jonasse), Djuba (Povoacao De Djuba)
40	Boane	Boane	Vila de Boane, GueGueGue	Bairro 1, Bairro 2, Bairro 3, Bairro 4, Bairro 5, Bairro 6, Picoco 2, Bairro 7 (Fiche), 25 De Setembro, Campoane (Campoane Povoacao), Campoane (Campoane Aldeia), Picoco 1, Belo Horizonte, Novo Bairro (Bairro Nov0)

Table K.4: Descriptions of "C" Zones within the Study Area

"C" Zone	"B" Zone	City/ District	Administrative District	Locality/ Urban District	Bairros/ Aldeias
11	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
12	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
13	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
14	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
15	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
16	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
17	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
18	1	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento A
21	2	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento B
22	2	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento B
23	2	Maputo City	DM KaMpfumu	Urban District 1	Polana Cimento B
31	3	Maputo City	DM KaMpfumu	Urban District 1	Central C
32	3	Maputo City	DM KaMpfumu	Urban District 1	Central C
33	3	Maputo City	DM KaMpfumu	Urban District 1	Central C
34	3	Maputo City	DM KaMpfumu	Urban District 1	Central C
35	3	Maputo City	DM KaMpfumu	Urban District 1	Central C
36	3	Maputo City	DM KaMpfumu	Urban District 1	Central C
41	4	Maputo City	DM KaMpfumu	Urban District 1	Central A
42	4	Maputo City	DM KaMpfumu	Urban District 1	Central A
43	4	Maputo City	DM KaMpfumu	Urban District 1	Central A
44	4	Maputo City	DM KaMpfumu	Urban District 1	Central B
45	4	Maputo City	DM KaMpfumu	Urban District 1	Central B
46	4	Maputo City	DM KaMpfumu	Urban District 1	Central B
47	4	Maputo City	DM KaMpfumu	Urban District 1	Central B
48	4	Maputo City	DM KaMpfumu	Urban District 1	Central B
49	4	Maputo City	DM KaMpfumu	Urban District 1	Central B
51	5	Maputo City	DM KaMpfumu	Urban District 1	Alto Maé A
52	5	Maputo City	DM KaMpfumu	Urban District 1	Alto Maé B
53	5	Maputo City	DM KaMpfumu	Urban District 1	Alto Maé A
54	5	Maputo City	DM KaMpfumu	Urban District 1	Alto Maé B
55	5	Maputo City	DM KaMpfumu	Urban District 1	Alto Maé B
61	6	Maputo City	DM Nhlamankulu	Urban District 2	Malanga
62	6	Maputo City	DM Nhlamankulu	Urban District 2	Malanga
63	6	Maputo City	DM Nhlamankulu	Urban District 2	Malanga
71	7	Maputo City	DM KaMpfumu	Urban District 1	Coop
72	7	Maputo City	DM KaMpfumu	Urban District 1	Sommershield
73	7	Maputo City	DM KaMpfumu	Urban District 1	Sommershield
74	7	Maputo City	DM KaMpfumu	Urban District 1	Coop
75	7	Maputo City	DM KaMpfumu	Urban District 1	Sommershield
76	7	Maputo City	DM KaMpfumu	Urban District 1	Sommershield
77	7	Maputo City	DM KaMpfumu	Urban District 1	Sommershield
78	7	Maputo City	DM KaMpfumu	Urban District 1	Sommershield
81	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene B
82	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene B
83	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene B
84	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene A
85	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene A
86	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene A
87	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene A
88	8	Maputo City	DM KaMpfumu	Urban District 1	Malhangalene A
91	9	Maputo City	DM KaMaxakeni	Urban District 3	Polana Caniço B
92	9	Maputo City	DM KaMaxakeni	Urban District 3	Polana Caniço A
101	10	Maputo City	DM KaMaxakeni	Urban District 3	Maxaquene D
102	10	Maputo City	DM KaMaxakeni	Urban District 3	Maxaquene A
103	10	Maputo City	DM KaMaxakeni	Urban District 3	Maxaquene B
104	10	Maputo City	DM KaMaxakeni	Urban District 3	Maxaquene C
111	11	Maputo City	DM Nhlamankulu	Urban District 2	Aeroporto A
112	11	Maputo City	DM KaMaxakeni	Urban District 3	Urbanização

"C" Zone	"B" Zone	City/ District	Administrative District	Locality/ Urban District	Bairros/ Aldeias
113	11	Maputo City	DM Nhlamankulu	Urban District 2	Munhuana
114	11	Maputo City	DM KaMaxakeni	Urban District 3	Urbanização
115	11	Maputo City	DM Nhlamankulu	Urban District 2	Minkadjuine
116	11	Maputo City	DM KaMaxakeni	Urban District 3	Mafalala
121	12	Maputo City	DM Nhlamankulu	Urban District 2	Aeroporto B
122	12	Maputo City	DM Nhlamankulu	Urban District 2	Aeroporto B
123	12	Maputo City	DM Nhlamankulu	Urban District 2	Chamanculo D
124	12	Maputo City	DM Nhlamankulu	Urban District 2	Aeroporto B
125	12	Maputo City	DM Nhlamankulu	Urban District 2	Xipamanine
126	12	Maputo City	DM Nhlamankulu	Urban District 2	Chamanculo C
127	12	Maputo City	DM Nhlamankulu	Urban District 2	Chamanculo B
128	12	Maputo City	DM Nhlamankulu	Urban District 2	Chamanculo A
131	13	Maputo City	DM KaMubukwana	Urban District 5	Inhagoia B
132	13	Maputo City	DM KaMubukwana	Urban District 5	Jardim
133	13	Maputo City	DM KaMubukwana	Urban District 5	Luis Cabral
140	14	Maputo City	DM KaMavota	Urban District 4	Costa Do Sol
151	15	Maputo City	DM KaMavota	Urban District 4	3 De Fevereiro
152	15	Maputo City	DM KaMavota	Urban District 4	Laulane
153	15	Maputo City	DM KaMavota	Urban District 4	Ferroviario
154	15	Maputo City	DM KaMavota	Urban District 4	Ferroviario
161	16	Maputo City	DM KaMavota	Urban District 4	Hulene B
162	16	Maputo City	DM KaMavota	Urban District 4	Hulene A
163	16	Maputo City	DM KaMavota	Urban District 4	Mavalane B
164	16	Maputo City	DM KaMavota	Urban District 4	Fplm
165	16	Maputo City	DM KaMavota	Urban District 4	Mavalane A
170	17	Maputo City	DM Nhlamankulu	Urban District 3	Aeroporto
181	18	Maputo City	DM KaMubukwana	Urban District 5	Malhazine
182	18	Maputo City	DM KaMubukwana	Urban District 5	George Dimitrov
183	18	Maputo City	DM KaMubukwana	Urban District 5	Bagamoio
184	18	Maputo City	DM KaMubukwana	Urban District 5	25 De Junho A
185	18	Maputo City	DM KaMubukwana	Urban District 5	25 De Junho B
186	18	Maputo City	DM KaMubukwana	Urban District 5	Inhagoia A
187	18	Maputo City	DM KaMubukwana	Urban District 5	Nsalene
190	19	Maputo City	DM KaMavota	Urban District 4	Albazine
200	20	Maputo City	DM KaMubukwana	Urban District 5	Magoanine A
210	21	Maputo City	DM KaMubukwana	Urban District 5	Zimpeto
221	22	Maputo City	Ka Tembe	Catembe	Chali, Inguide
222	22	Maputo City	Ka Tembe	Catembe	Chamissava, Guachene, Incassane
231	23	Matola	Matola	Matola	Matola A
232	23	Matola	Matola	Matola	Matola A
241	24	Matola	Matola	Matola	Trevo
242	24	Matola	Matola	Matola	Trevo
243	24	Matola	Matola	Matola	Trevo
251	25	Matola	Matola	Matola	Matola C
252	25	Matola	Matola	Matola	Matola B
261	26	Matola	Matola	Matola	Matola G
262	26	Matola	Matola	Matola	Matola F
263	26	Matola	Matola	Matola	Fomento
271	27	Matola	Matola	Matola	Mossumbuluku
272	27	Matola	Matola	Matola	Mossumbuluku
273	27	Matola	Matola	Matola	Matola J
274	27	Matola	Matola	Matola	Matola J
275	27	Matola	Matola	Matola	Matola D
276	27	Matola	Matola	Matola	Matola D
281	28	Matola	Matola	Matola	Liberdade
282	28	Matola	Matola	Matola	Matola H
291	29	Matola	Machava	Machava	Machava Central
293	29	Matola	Machava	Machava	Machava A, Patrice Lumumba
301	30	Matola	Infulene	Infulene	Unidade D

"C" Zone	"B" Zone	City/ District	Administrative District	Locality/ Urban District	Bairros/ Aldeias
302	30	Matola	Infulene	Infulene	T-3
303	30	Matola	Infulene	Infulene	Acordos De Lusaka
304	30	Matola	Infulene	Infulene	Vale Do Infulene
311	31	Matola	Machava	Machava	Tsalala
312	31	Matola	Matola	Matola	Malhampsane
313	31	Matola	Matola	Matola	Cikuama
321	32	Matola	Machava	Machava	Bunhica
322	32	Matola	Machava	Machava	Singatela
323	32	Matola	Machava	Machava	S. Damanso
331	33	Matola	Infulene	Infulene	1O Maio
332	33	Matola	Infulene	Infulene	Congolote
333	33	Matola	Infulene	Infulene	Ndlavela
334	33	Matola	Infulene	Infulene	Zona Verde
341	34	Matola	Machava	Machava	Matola Gare
342	34	Matola	Machava	Machava	Uamatibwana
351	35	Matola	Machava	Machava	Cobe
352	35	Matola	Machava	Machava	Km 15
361	36	Matola	Infulene	Infulene	Mucatine
362	36	Matola	Infulene	Infulene	Golhoza
363	36	Matola	Machava	Machava	Matlhemele
372	37	Matola	Infulene	Infulene	Boquisso, Mali
373	37	Matola	Infulene	Infulene	Muhalaze
374	37	Matola	Infulene	Infulene	Intaca
381	38	Marracuene	Marracuene	Marracuene Sede, Nhomgonhane	Mbuva, Macaneta 1, Hobjane, Mapulango, Macaneta 2, Pussulana(E), Aldeia Samora Machel
382	38	Marracuene	Marracuene	Vila de Marracuene, Marracuene Sede, Michafutene	Massinga, Da Vila, 29 Setembro, Mikanhine, Zintava, Muntanhana(E), Faftine, Abel Jafar, Povoado De Guava, Momemo 4 De Outubro
392	38	Marracuene	Marracuene	Michafutene	Mali, Cumbeza (Povoado De Cumbeza), Agustinho Neto (Aldeia), Ricatla, Povoado De Momemo 15 De Agosto, Povoado De Mumemo 1
401	39	Boane	Matola Rio	Matola Rio	Belaluene (Povoacao De Beluluane), Djuba (Povoacao De Djuba)
402	39	Boane	Matola Rio	Matola Rio	Jonasse (Povoacao De Jonasse)
403	39	Boane	Matola Rio	Matola Rio	Chinonoquila
404	40	Boane	Boane	GueGueGue	Picoco 1
405	40	Boane	Boane	GueGueGue	Campoane (Campoane Aldeia), Belo Horizonte
406	40	Boane	Boane	GueGueGue	Campoane (Campoane Povoacao), Novo Bairro (Bairro Nov0)
407	40	Boane	Boane	Vila de Boane	Bairro 1, Bairro 2, Bairro 3, Bairro 4, Bairro 5, Bairro 6, Picoco 2
408	40	Boane	Boane	Vila de Boane, GueGueGue	Bairro 7 (Fiche), 25 De Setembro

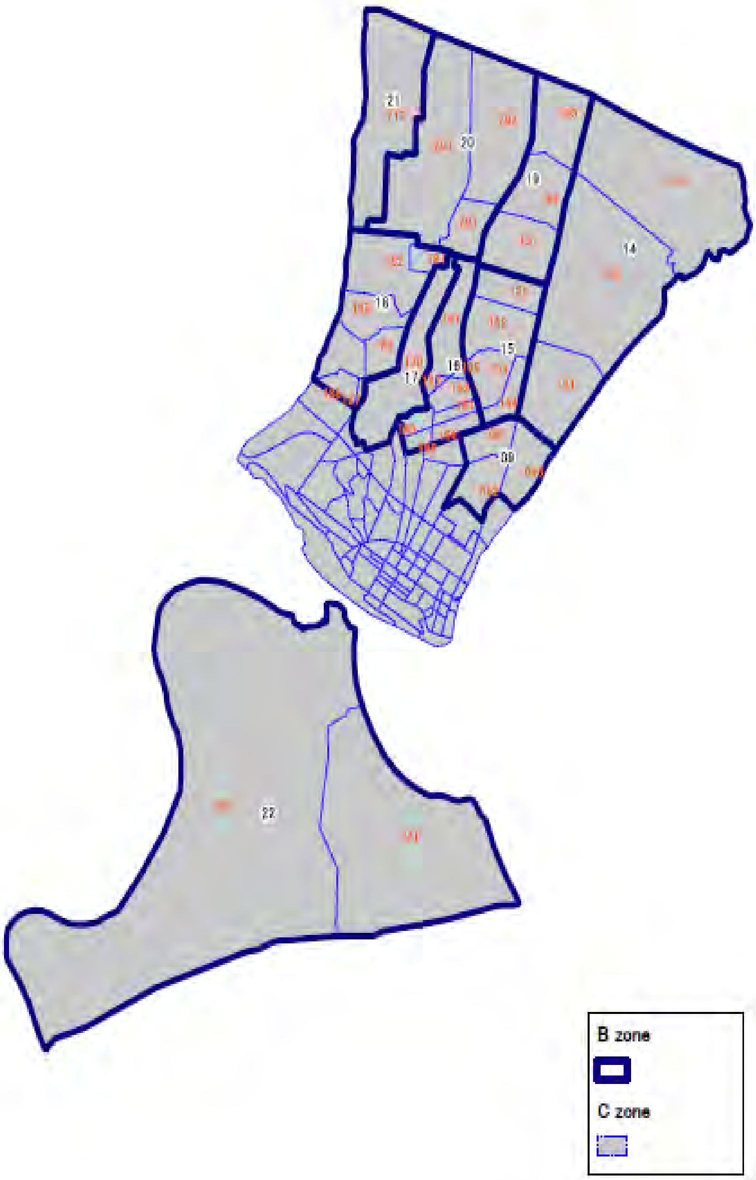


Figure K.6: "B" and "C" Zones in Maputo City

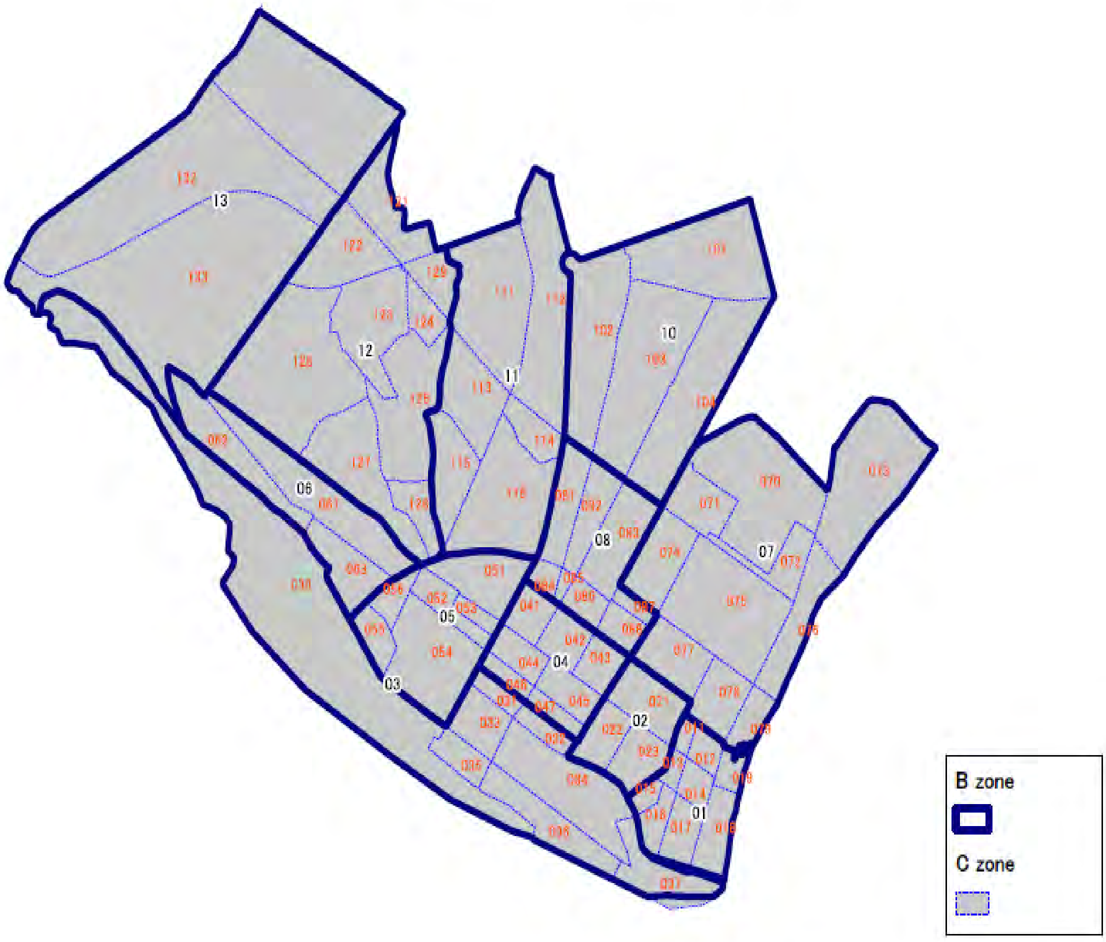


Figure K.7: "B" and "C" Zones in Maputo City Centre

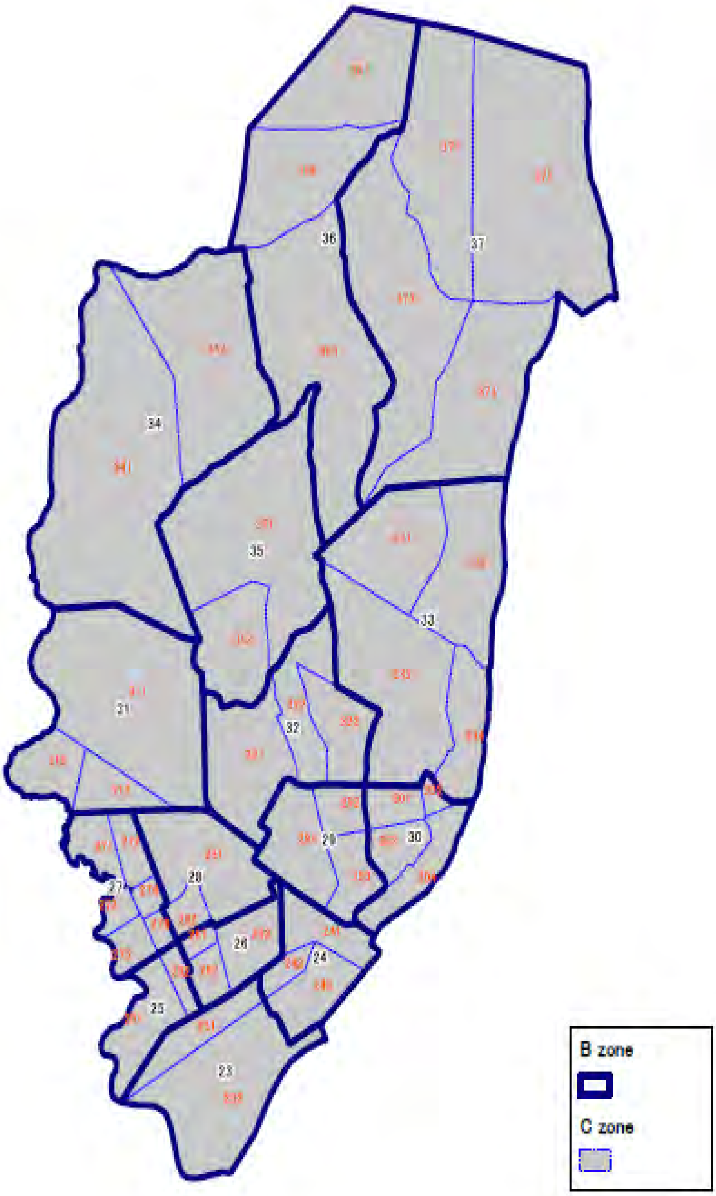


Figure K.8: "B" and "C" Zones in Matola

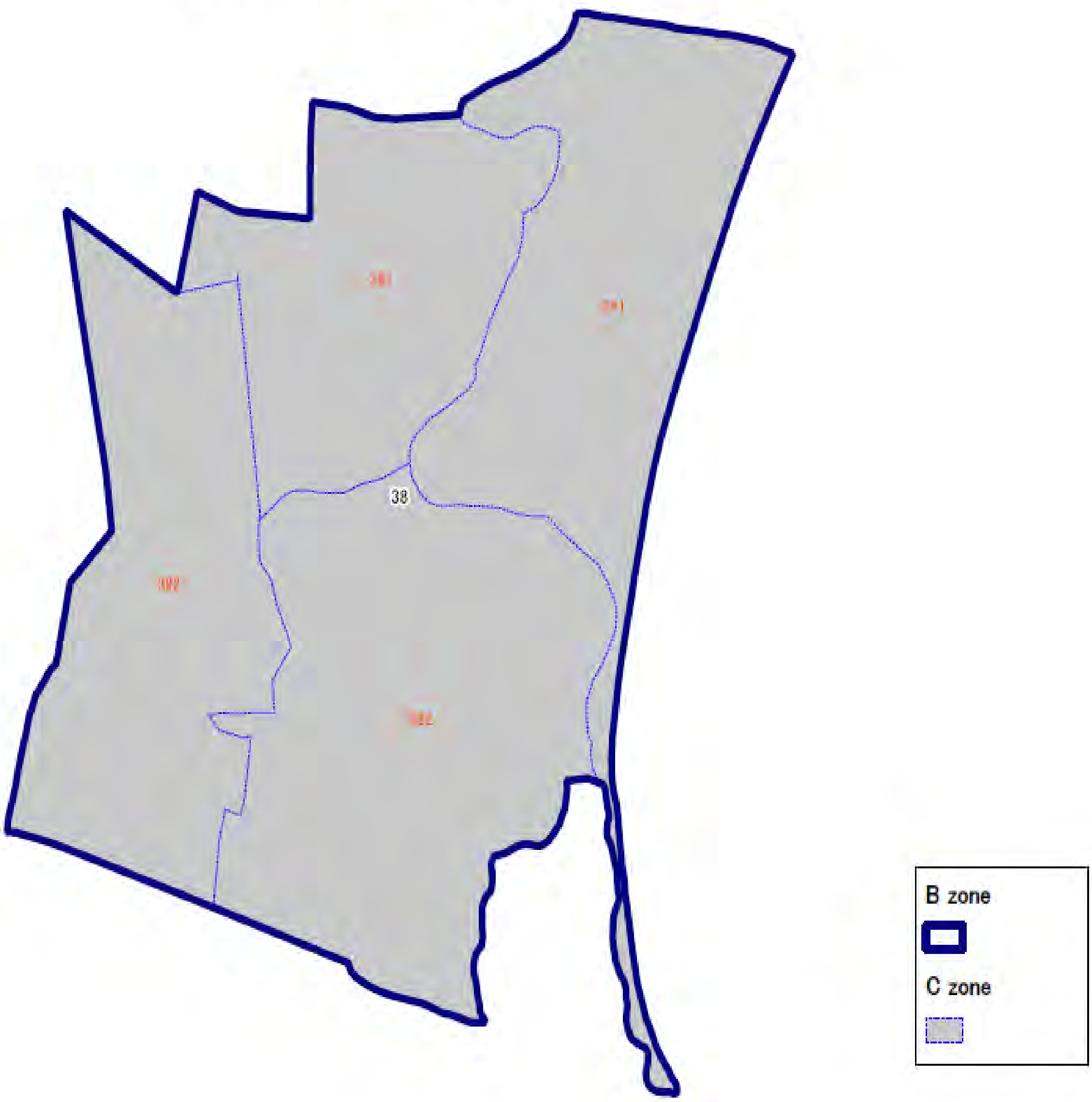


Figure K.9: "B" and "C" Zones in Marracuene

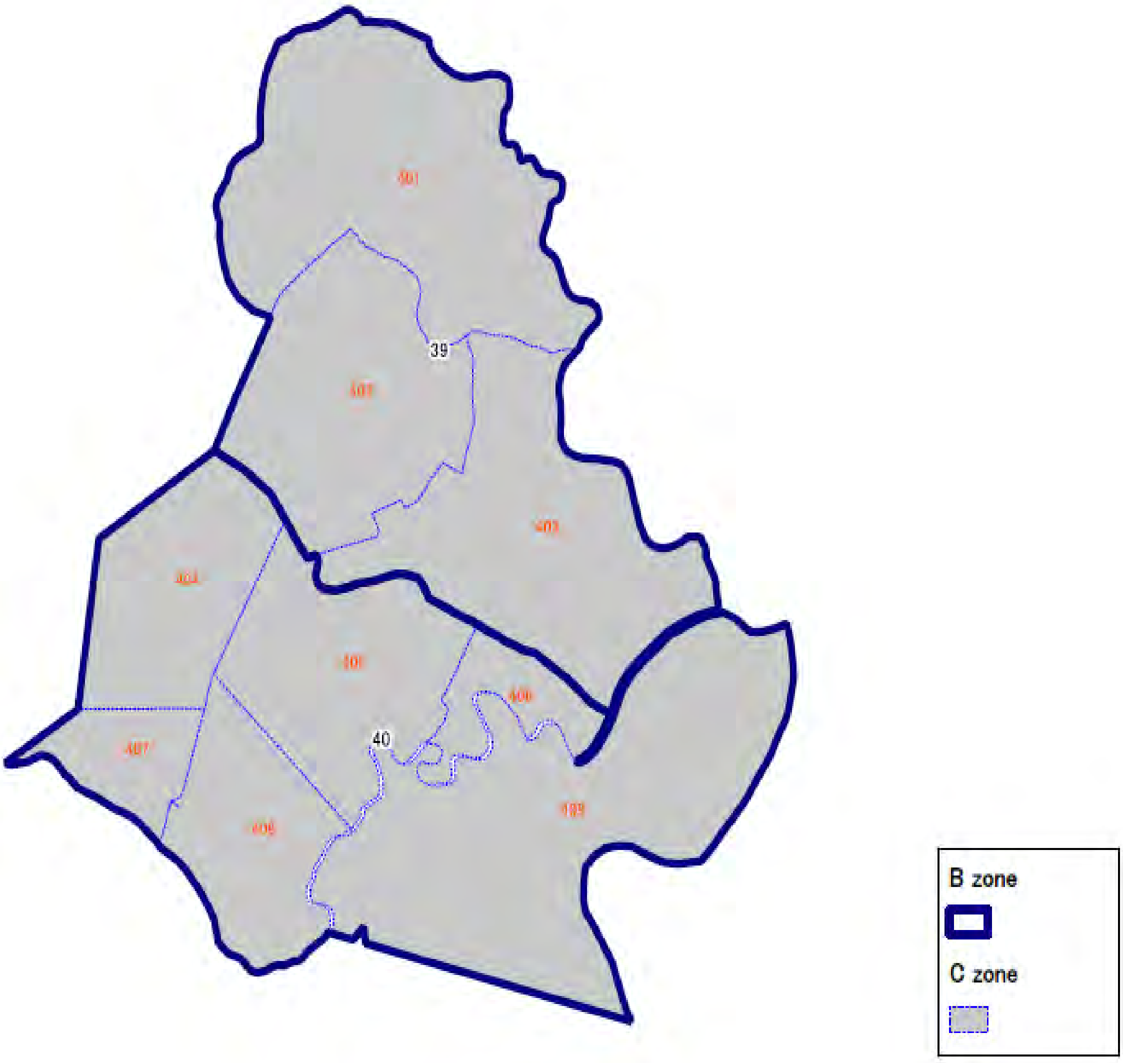


Figure K.10: "B" and "C" Zones in Boane

(4) Zoning Definitions Outside the Study Area

In addition, in order to allow for trips to/from areas outside of the study area, zoning was used as shown in Table K.5. These zones are also shown in Figure K.11 and Figure K.12.

Table K.5: Zone Definitions Outside Study Area

Zone Number	Country	Province	District
500	Mozambique	Maputo City	Inhaca
510		Maputo Province	Marracuene (outside Study Area)
521			Boane (North; outside Study Area)
522			Boane (South; outside Study Area)
530			Matutuine
540			Namaacha
550			Moamba
560			Manhica
570			Magude
610		Gaza	
620		Inhambane	
630		Manica	
640		Sofala	
650		Tete	
660		Zambezia	
670		Nampula	
680		Niassa	
690		Cabo Delgado	
701	South Africa	KwaZulu-Natal (i.e. east of Swaziland)	
702		Rest of South Africa	
710	Swaziland		
720	Zimbabwe		
730	Zambia		
740	Malawi		
750	Tanzania		

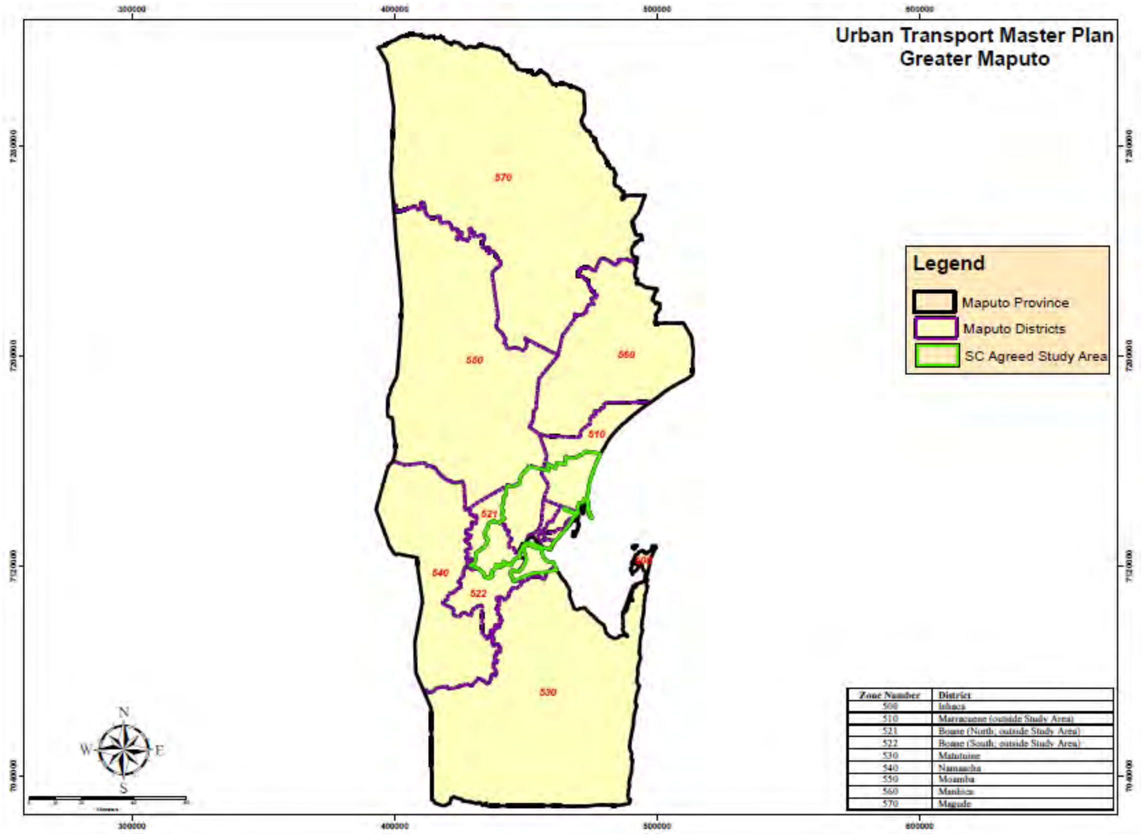


Figure K.11: Zones Outside Study Area: Inhaca and Maputo Province

Figure K.12: Zones Outside Study Area: Mozambican Provinces and Overseas

K.3.4 Questionnaire

The survey forms comprise the following.

- A control data sheet (front page), as shown in Figure K.13
- Form 1: Household and individual information, as shown in Figure K.14
- Form 2: Individual Trip information (one form for each household member aged 6 years old or above), as shown in Figure K.15

Household Interview Survey on The Daily Urban Traffic
for
The Study on The Development of The Urban Traffic Network
of
Maputo Urban Area

This is a household interview survey for developing the urban traffic network in Maputo urban area. The new plan will be developed targeting the year of 2018, 2025 and 2035. As part of revising the plan, the household interview survey is conducted to identify daily movements of individuals and the preference of transportation modes.

INSTRUCTION FOR ANSWERING QUESTIONNIARE FORMS

Please answer all the questions one by one sequentially. Print the information in the space provided or put a check mark in the appropriate box.

Form 1: Household and Householid menber information

To be completed with the member of the household when the interviewer visits the household.
To be completed for every household member who is more than 6 year-old.

Form 2: Daily Activity Information

FOR OFFICIAL USE ONLY

It should be completed for every member of household who is more than 6 year-old.
Only the selected members of household (the head of the household or other) should complete. (Please specify their member code)

Q1 Questionnaire Control Information

a. HIS Zone No.	CZone No	1a	
b. Household No.		1b	
c. Bairi cide No.	BZone No	1C	

Q2 Name of person in charge of this survey sheet

a. Interviewer		2a	
b. Supervisor		2b	
c. Editor		2c	
d. Coder		2d	
e. Data Input		2e	

Q3 Survey Date

	Month/Day		Month	Day
Survey Date		3		

Q4 Visit Date

Visit Date	Month /Day		Month	Day
a. 1st Contact(Visit)		4a		
b. 2ndContact(Visit or call)		4b		
c. 3rd contact(Visit or Call)		4c		

	S	
E	E	

Figure K.13: Front Page of HIS Form

Form1: Household Information

	1a			1b			1c	

INSTRUCTION: To be completed with a household member and the Interviewer when the interviewer visits the household.

Q5 Name of household head

Q6 Address of household

(Province/City) (District)
(Bairo) (Quarter)
(Street) (Building Number)
(Floor) (Room No.)

HIS Zone No.
6

Q7 Tel. Number

7

Q8 In case you have a vehicle, write the number of its vehicle

a	b	c	d	e	f	g
Small Car	Standard Car	Light Van	Small Truck	Standard Truck	Motorcycle	Bicycle

Q9 Household composition

Number of Household Members	living type	6 year-old and above	Under 6 year-old	
	living currently together	a	c	
	living outside	b	d	

Household menbers living together

e No	Name	f Sex	g Age	h Occupation	i Activity	j Licence	Work or School Address: Province/District	Bairro/Quarter	Name of Company, School,,B	k HIS Zone No.
01										
02										
03										
04										
05										
06										
07										
08										
09										
10										

Sex
1 Masculino
2 Feminino

Occupation
01 Manager
02 Professional
03 Office Employee
04 Independent Technician
05 Labor
06 Vender
07 Unskilled independent Worker
08 Police/Army
09 Driver
10 Guard
11 Student((elementay and high)
12 Student(Univ.)
13 Student(Worker)
14 Housewife
15 Household servant
16 Jobless
17 Others

Activity
01 Agriculture
02 Fishery
03 Mining
04 Manufactuaring
05 Electricity
06 Construction
07 Comercial,restaurant, Hotel
08 Transport,cominic,storage
09 Financial,insurance
10 Education
11 Health/social work
12 Piblic Service
13 Private Service
14 Domestic Service
15 Others

Driver's License
1 Car
2 Motorcycle
3 Both
4 None

Q10 How muchi is the income of whole family on last month?

l MT

Figure K.14: HIS Form 1: Household Information

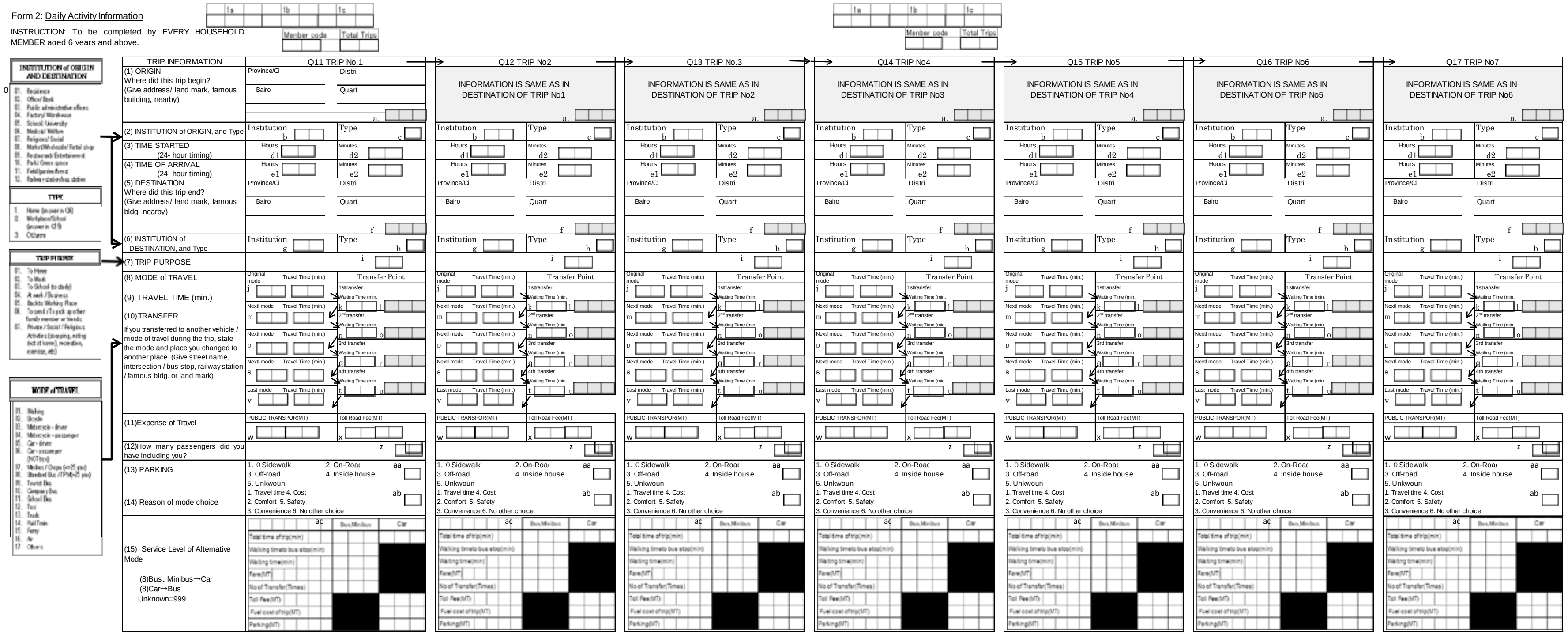


Figure K.15: HIS Form 2: Trip Information

K.3.5 Results and Analysis

The results and analysis of the HIS are described in Technical Report N (Demand Forecasting: Methodology and Analysis).

K.4 Cordon and Screenline Surveys

K.4.1 Purpose

Screen line surveys were conducted within the study area, in order to understand transport movements within the study area. Screen line surveys comprised classified vehicular traffic counts on links (roads), together with passenger occupancy surveys of passenger vehicles.

Cordon surveys were conducted at the boundary of the study area, in order to understand transport movements into and out of the study area. These comprised:

- Classified vehicular traffic counts, for all vehicles
- Origin-destination (OD) interview surveys, comprising:
    - Road-side interview (RSI) and occupancy surveys for private passenger vehicles (e.g. cars)
    - Onboard surveys of bus and chapa passengers, together with occupancy surveys
    - Truck interview surveys

K.4.2 Survey Locations and Timing

The surveys were conducted on normal weekdays, i.e. Tuesday, Wednesday or Thursdays in a week with no public holidays or school holidays. Figure K.16 shows the survey locations. Cordon sites are located at the boundary of the study area. Within the study area, two screenlines are defined: A and B.

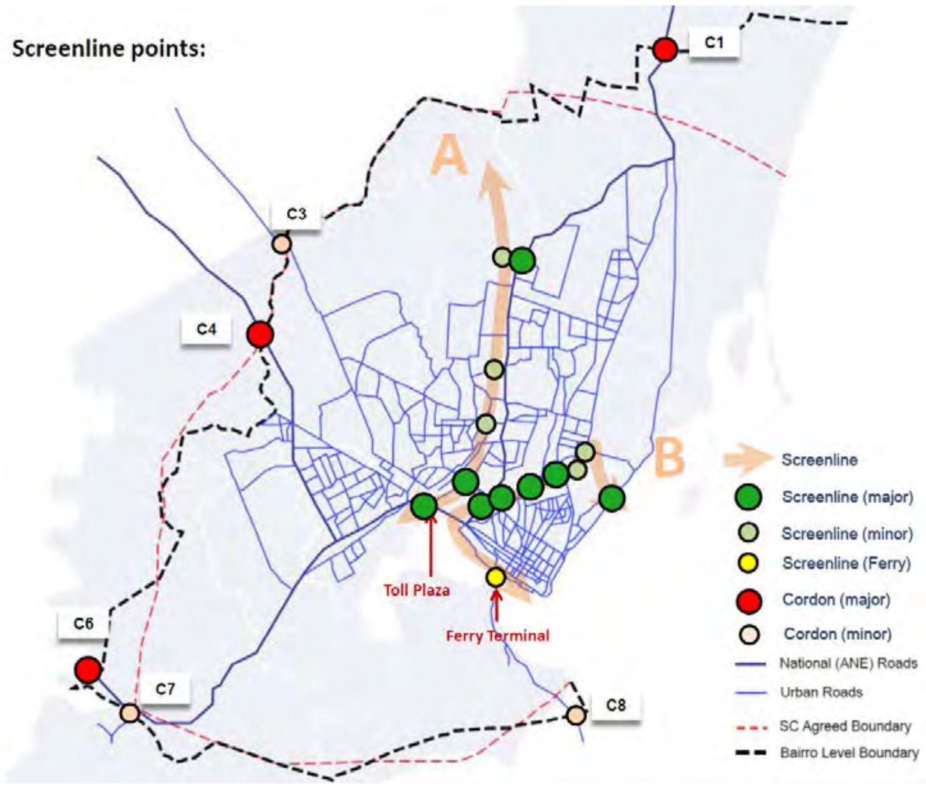


Figure K.16: Locations of Cordon and Screenline Surveys

The survey locations for Screenline A and Screenline B are shown in more detail in Figure K.17 and Figure K.18 respectively.

Figure K.17: Screenline A Survey Locations

Figure K.18: Screenline B Survey Locations

K.4.3 Analysis Methodology

(1) Classified Traffic Counts

Classified traffic counts were undertaken depending upon the site, for 24 hours, 16 hours or in some cases for a different number of hours.

Based upon analysis of hourly patterns at those sites with 24 hour counts, traffic counts at those sites without 24 hour counts were expanded to 24 hour totals by vehicle type.

(2) Vehicle Occupancies

Passenger vehicle occupancy data were collected for a proportion of vehicles at traffic count sites. Sample data were expanded to the respective classified vehicle count total (by hour or group of hours) and thence to daily totals, so as to give passenger totals in addition to vehicle count data.

(3) RSI Data (Cordon Sites Only)

Road-side interview data pertaining to trip origins, destinations and purpose were expanded to traffic count totals by time period and thence to daily in a manner similar to that undertaken for vehicle occupancy data.

K.4.4 Results and Analysis

(1) Classified Traffic Counts

Classified traffic count results in vehicles are shown in Table K.6 (Screenline A), Table K.7 (Screenline B) and Table K.8 (Cordon). Results are given for two-way 24-hour totals by vehicle type.

Table K.6: Classified Traffic Counts: Screenline A

Site	Bicycle/ Motorcycle	Car/Taxi	Chapa/ Minibus	Bus/ Coach	Truck	Total
A1	385	21,774	8,227	694	3,138	34,219
A2	558	12,119	6,790	718	1,980	22,165
A3	342	4,579	5,422	63	1,390	11,797
A4	167	1,842	1,009	30	310	3,358
A5	68	709	730	10	178	1,694
A6	130	4,673	3,703	196	1,588	10,290
Total	1,651	45,696	25,880	1,712	8,585	83,524

Table K.7: Classified Traffic Counts: Screenline B

Site	Bicycle/ Motorcycle	Car/Taxi	Chapa/ Minibus	Bus/ Coach	Truck	Total
B1	25	67	91	0	146	329
B2	564	15,983	11,705	875	2,579	31,705
B3	318	9,976	2,645	205	1,000	14,144
B4	269	6,123	3,392	46	1,471	11,301
B5	524	9,649	7,029	540	1,135	18,878
B6	48	1,129	1,083	1	35	2,296
B7	35	883	753	15	132	1,818
B8	209	8,444	1,893	48	2,164	12,757
Total	1,993	52,253	28,591	1,730	8,661	93,228

Table K.8: Classified Traffic Counts: Cordon Sites

Site	Bicycle/ Motorcycle	Car/Taxi	Chapa/ Minibus	Bus/ Coach	Truck	Total
C1	44	1,765	1,152	142	876	3,978
C3	137	435	312	8	386	1,279
C4	84	4,191	1,980	159	3,542	9,956
C6	81	1,592	615	32	1,202	3,521
C7	337	666	344	49	146	1,543
C8	14	226	173	0	90	504
Total	696	8,874	4,576	391	6,244	20,781

(2) Vehicle Occupancies

Vehicle occupancies (total passengers) are shown in Table K.9 (Screenline A), Table K.10 (Screenline B) and Table K.11 (Cordon). Results are given for two-way 24-hour totals by vehicle type. Note that passenger occupancies of trucks were not collected.

Table K.9: Classified Traffic Counts: Screenline A

Site	Bicycle/ Motorcycle	Car/Taxi	Chapa/ Minibus	Bus/ Coach	Total
A1	452	40,359	100,551	52,727	194,089
A2	657	27,448	92,708	47,720	168,533
A3	391	9,997	69,238	1,613	81,240
A4	189	5,103	5,563	304	11,158
A5	75	1,658	9,162	628	11,523
A6	152	11,774	52,739	12,700	77,365
Total	1,915	96,339	329,961	115,692	543,907

Table K.10: Classified Traffic Counts: Screenline B

Site	Bicycle/ Motorcycle	Car/Taxi	Chapa/ Minibus	Bus/ Coach	Total
B1	29	202	240	0	471
B2	662	30,596	147,693	40,435	219,385
B3	372	28,170	38,139	13,621	80,303
B4	314	13,676	42,020	1,781	57,790
B5	608	18,503	75,579	34,742	129,433
B6	55	2,209	13,041	77	15,382
B7	42	1,966	6,106	947	9,063
B8	241	19,354	18,097	1,532	39,223
Total	2,323	114,676	340,915	93,135	551,049

Table K.11: Classified Traffic Counts: Cordon Sites

Site	Bicycle/ Motorcycle	Car/Taxi	Chapa/ Minibus	Bus/ Coach	Total
C1	46	4,505	18,285	3,403	26,239
C3	151	1,072	6,768	218	8,209
C4	92	9,320	26,548	3,344	39,303
C6	81	4,243	8,934	843	14,101
C7	353	2,012	10,077	1,291	13,733
C8	15	744	2,900	0	3,658
Total	737	21,895	73,512	9,099	105,243

(3) RSI Data (Cordon Sites Only)

Trip matrices by vehicle type are summarized in Table K.12 (vehicles) and Table K.13 (passengers). No passenger occupancies were directly surveyed for goods vehicles.

Table K.12: Daily Vehicle Trip Matrix Summary from Cordon Sites

		To					
From		1	2	3	4	5	Total
Motorcycle							
Maputo	1	0	0	2	0	17	19
Matola	2	14	50	0	33	0	97
Marracuene	3	0	0	7	0	8	15
Boane	4	5	5	0	35	0	45
External	5	4	0	0	0	0	4
Total		23	56	9	67	25	180
Car & Taxi							
Maputo	1	14	406	16	165	1,678	2,278
Matola	2	579	1,280	25	230	572	2,685
Marracuene	3	31	10	16	0	27	85
Boane	4	165	74	0	218	103	559
External	5	1,152	124	10	84	327	1,697
Total		1,941	1,894	68	696	2,706	7,304
Chapa & Minibus							
Maputo	1	71	132	16	9	879	1,109
Matola	2	48	299	3	70	282	702
Marracuene	3	25	0	19	2	31	78
Boane	4	2	130	0	138	257	528
External	5	845	240	16	204	467	1,772
Total		992	801	55	423	1,917	4,188
Bus & Coach							
Maputo	1	8	97	1	0	23	130
Matola	2	1	62	0	1	0	64
Marracuene	3	24	0	1	0	0	25
Boane	4	0	0	0	0	0	0
External	5	116	15	0	27	8	166
Total		150	174	2	28	31	385
Goods Vehicles							
Maputo	1	30	278	12	53	922	1,294
Matola	2	195	1,359	32	232	708	2,527
Marracuene	3	45	19	8	1	32	104
Boane	4	42	117	0	36	150	345
External	5	928	500	54	174	194	1,850
Total		1,240	2,274	105	496	2,005	6,121

Table K.13: Daily Person Trip Matrix Summary from Cordon Sites

		To					
From		1	2	3	4	5	Total
Motorcycle							
Maputo	1	0	0	2	0	22	24
Matola	2	15	67	0	32	0	114
Marracuene	3	0	0	8	0	10	18
Boane	4	7	6	0	49	0	61
External	5	4	0	0	0	0	4
Total		25	73	9	81	32	220
Car & Taxi							
Maputo	1	42	1,015	40	414	4,269	5,781
Matola	2	1,202	3,016	49	581	1,433	6,281
Marracuene	3	87	29	40	0	68	224
Boane	4	547	243	0	612	255	1,657
External	5	3,065	370	29	250	824	4,538
Total		4,943	4,673	159	1,858	6,848	18,481
Chapa & Minibus							
Maputo	1	1,360	1,987	251	209	13,591	17,397
Matola	2	1,240	4,195	47	902	5,303	11,687
Marracuene	3	551	0	365	54	471	1,441
Boane	4	77	1,603	0	2,151	3,118	6,949
External	5	12,656	3,587	244	5,166	8,161	29,813
Total		15,883	11,371	906	8,481	30,645	67,286
Bus & Coach							
Maputo	1	109	842	122	71	2,501	3,646
Matola	2	122	509	0	143	0	774
Marracuene	3	326	0	11	0	0	337
Boane	4	0	0	0	0	36	36
External	5	1,591	580	0	1,982	109	4,262
Total		2,148	1,932	133	2,196	2,646	9,055

K.5 Freight Surveys

K.5.1 Purpose

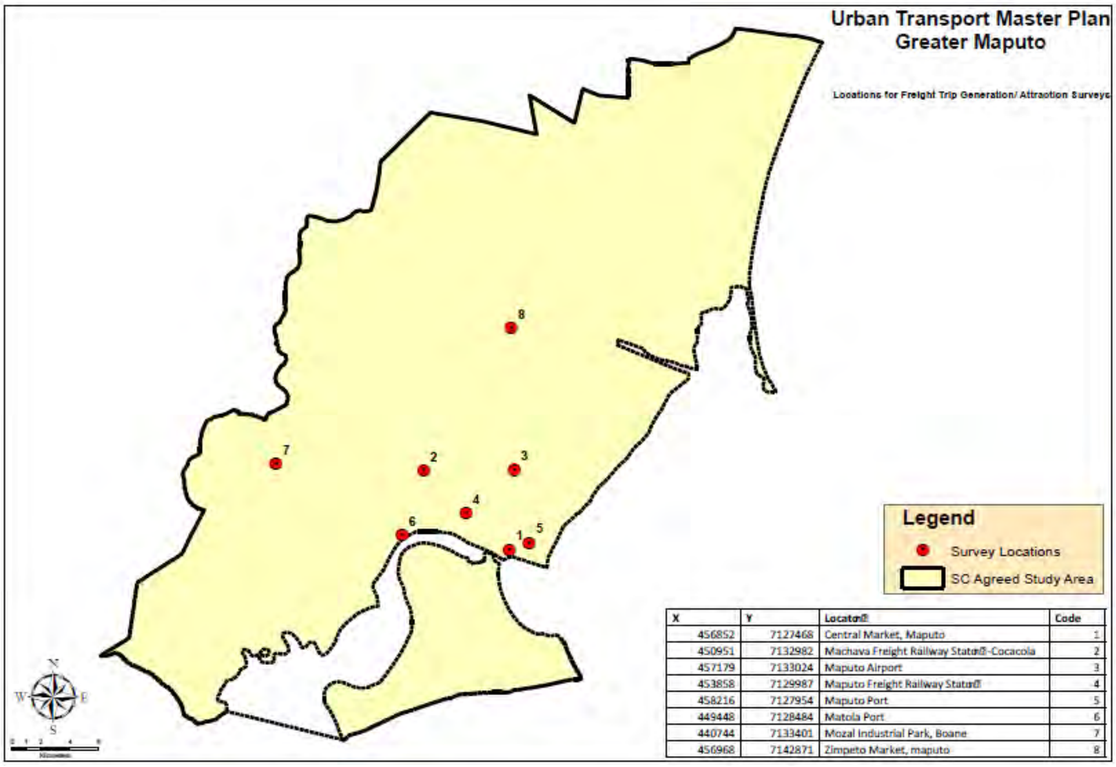
In addition to data on truck movements collected as part of the Cordon Survey RSI's, additional freight surveys were conducted in order to better understand freight movements within the study area.

These comprised classified vehicle counts, together with interviews with freight vehicles.

K.5.2 Locations

Freight surveys at the following locations, whose approximate locations are shown in Figure K.19:

- Site 1: Mercado Central, Maputo (one-way road)
- Site 2: Machava Freight Railway Station:
- Site 3: Maputo Airport
- Site 4: Maputo Port
- Site 6: Matola Port
- Site 7: Mozal Industrial Park, Boane
- Site 8: Zimpeto Market, Maputo



X	Y	Location	Code
456852	7127468	Central Market, Maputo	1
450951	7132982	Machava Freight Railway Station-Cocacola	2
457179	7133024	Maputo Airport	3
453858	7129987	Maputo Freight Railway Station	4
458216	7127954	Maputo Port	5
449448	7128484	Matola Port	6
440744	7133401	Mozal Industrial Park, Boane	7
456968	7142871	Zimpeto Market, maputo	8

Figure K.19: Freight Survey Locations

K.5.3 Analysis Methodology

(1) Classified Traffic Counts

Classified traffic counts were undertaken depending upon the site, typically for 14 hours, but in the case of markets for opening hours.

Based upon analysis of hourly patterns at those sites with 24 hour counts (e.g. from Cordon and Screenline Surveys), traffic counts at those sites without 24 hour counts were expanded to 24 hour totals by vehicle type.

(2) RSI Data

Road-side interview data pertaining to trip origins, destinations and other characteristics of the goods vehicle trips were expanded to traffic count totals by time period and thence to daily in a manner similar to that undertaken for RSI data from Cordon Surveys.

K.5.4 Results and Analysis

(1) Classified Traffic Counts

Classified traffic count results in vehicles, expanded to 24 hours, are shown in Table K.14. Note that these data were collected for all vehicle types.

Table K.14: Classified Traffic Counts: Freight Survey Locations

Site	Bicycle/ Motorcycle	Car/Taxi	Chapa/ Minibus	Bus/ Coach	Truck	Total
F1	181	2,173	231	0	60	2,645
F2	399	9,678	7,187	305	5,127	22,697
F3	225	6,191	1,157	19	677	8,269
F4	63	1,720	402	16	1,502	3,703
F6	77	1,463	752	47	1,226	3,565
F7	325	4,850	1,443	139	1,588	8,345
F8	42	1,296	333	0	805	2,476
Total	1,312	27,371	11,504	526	10,986	51,699

Note: Site F1 was one-way; all others two-way.

(2) Trip Matrix Data

Table K.15 shows the daily goods vehicle trip matrix summary obtained from the freight survey sites, by goods vehicle type.

Table K.15: Daily Goods Vehicle Trip Matrix Summary from Freight Survey Sites

		To					
From		1	2	3	4	5	Total
Pick-Ups							
Maputo	1	313	198	14	65	27	617
Matola	2	407	253	50	309	15	1,034
Marracuene	3	30	4	0	0	0	34
Boane	4	85	126	0	14	28	252
External	5	19	11	0	33	0	62
Total		853	591	65	421	70	1,999
2 & 3 axle Trucks							
Maputo	1	775	1,086	34	182	221	2,299
Matola	2	1,164	794	35	543	55	2,592
Marracuene	3	34	16	0	16	0	65
Boane	4	315	359	39	39	7	760
External	5	321	163	20	13	8	524
Total		2,609	2,419	128	793	291	6,240
>3 axles							
Maputo	1	272	450	0	82	291	1,095
Matola	2	511	256	15	302	68	1,151
Marracuene	3	0	4	0	7	7	18
Boane	4	133	263	0	0	53	448
External	5	404	88	44	50	0	585
Total		1,319	1,061	59	441	419	3,298
Container Vehicles							
Maputo	1	77	186	0	20	22	304
Matola	2	257	66	0	103	6	432
Marracuene	3	1	0	0	0	0	1
Boane	4	88	65	0	0	0	154
External	5	72	14	15	13	7	120
Total		495	331	15	135	35	1,011
All GV							
Maputo	1	1,437	1,920	48	349	561	4,316
Matola	2	2,339	1,370	100	1,257	143	5,208
Marracuene	3	65	23	0	23	7	118
Boane	4	620	814	39	53	88	1,614
External	5	815	275	79	108	15	1,292
Total		5,277	4,401	267	1,790	814	12,549

K.6 Junction Surveys

K.6.1 Purpose

Further traffic surveys were conducted, primarily in the centre of Maputo. These comprised junction surveys, requiring the collection of classified vehicle turning movement data at 15 minute intervals. These surveys were intended both to provide additional information to assist in model calibration and to inform the traffic management works.

K.6.2 Timing and Locations

Surveys were conducted from 0500–2100 hours. The locations of surveys are shown in Figure K.20. Of the 14 sites shown, full turning movements were collected at 12 sites, whilst at two sites link flow counts only were required.

Figure K.20: Junction Survey Locations

K.6.3 Analysis Methodology

As part of the survey data error checking, it was necessary to ensure that inbound and outbound movements reconciled within each time period.

Data were expanded to 24 hours for use in the transport modelling. This was done using expansion factors generated from the Cordon and Screenline Surveys.

In addition, once vehicle movements were known, it was possible to estimate passenger movements, using vehicle occupancy data collected during the Cordon and Screenline Surveys.

K.6.4 Results and Analysis

Classified traffic count results in vehicles, expanded to 24 hours, are shown in Table K.16. Similarly, Table K.17 shows passenger movement summaries (excluding trucks as no passenger occupancies were collected for goods vehicles).

Table K.16: Junction Survey Summary Results (24 hour Vehicles by Movement)

At		In	Inbound/ Outbound	Arm		Bicycle & Motorcycle	Car & Taxi	Chapa & Minibus	Bus & Coach	Truck	Total
J01	Roads N2/ N4 And Av Abel Baptista	Matola	Inbound	N	Road N4, to Ressano Garcia	211	11,238	3,077	193	1,817	16,536
				S	Av Abel Baptista	126	5,975	764	23	385	7,274
				E	Road N4, to Maputo	205	11,015	2,325	229	2,120	15,893
				W	Road N2, to Boane	121	8,529	2,185	154	1,174	12,163
			Outbound	N	Road N4, to Ressano Garcia	180	10,174	2,604	129	2,021	15,109
				S	Av Abel Baptista	140	6,335	517	43	631	7,667
				E	Road N4, to Maputo	178	14,020	2,386	260	2,198	19,040
				W	Road N2, to Boane	175	6,197	2,923	171	894	10,359
J02	Roads Av Eduardo Mondlane/ Av Das Industrias	Matola	Inbound	N	Av Eduardo Mondlane, to Estadio da Machava	169	5,074	2,301	122	1,716	9,381
				S	Av Eduardo Mondlane, to the tollgate	212	6,852	2,591	125	1,500	11,280
				E	n/a						
				W	Av das Industrias	125	4,651	1,721	46	468	7,011
			Outbound	N	Av Eduardo Mondlane, to Estadio da Machava	185	5,713	2,800	109	1,345	10,153
				S	Av Eduardo Mondlane, to the tollgate	173	6,863	2,055	124	1,264	10,480
				E	n/a						
				W	Av das Industrias	140	4,023	1,686	54	593	6,496
J03	Roads N1 And Av Maria De Lurdes Mutola	Maputo	Inbound	N	Road N1, to Marracuene	232	7,862	4,892	358	1,028	14,372
				S	Road N1, to Benfica	144	4,261	2,849	256	1,289	8,799
				E	Av Lurdes Mutola	138	4,196	3,169	165	781	8,449
				W	n/a						
			Outbound	N	Road N1, to Marracuene	207	5,776	3,965	303	1,468	11,720
				S	Road N1, to Benfica	197	6,841	3,925	336	953	12,251
				E	Av Lurdes Mutola	109	3,694	3,049	140	693	7,685
				W	n/a						
J04	Roads Av Maria De Lurdes Mutola/ Sebastião Marcos Mabote/ Mario Esteves Coluna And Julius Nyerere	Praça Da Juventude - Maputo	Inbound	N	Av Sebastio Marcos Mabote	213	3,413	1,341	189	605	5,762
				S	Av Julius Nyerere	243	5,055	2,675	306	459	8,738
				E	Rua Mario Esteves Coluna	113	2,699	244	21	309	3,387
				W	Av Lurdes Mutola	156	3,357	1,727	136	662	6,038
			Outbound	N	Av Sebastio Marcos Mabote	227	4,256	1,544	206	423	6,657
				S	Av Julius Nyerere	270	4,434	1,981	275	821	7,782
				E	Rua Mario Esteves Coluna	42	675	319	46	139	1,221
				W	Av Lurdes Mutola	189	5,229	2,139	124	647	8,328

At		In	Inbound/ Outbound	Arm		Bicycle & Motorcycle	Car & Taxi	Chapa & Minibus	Bus & Coach	Truck	Total
J05	Roads Av Julius Nyerere And Rua Da Beira	Maputo	Inbound	N	Av. Julius Nyerere, to Praca de Juventude	357	5,566	2,354	355	695	9,327
				S	Av. Julius Nyerere, to Praca dos Combatentes	278	3,491	2,470	309	428	6,977
				E	Rua de Beira	137	2,587	318	65	381	3,488
				W	Rua de Beira, to the airport	257	4,472	2,297	123	437	7,587
			Outbound	N	Av. Julius Nyerere, to Praca de Juventude	380	5,428	2,524	308	722	9,361
				S	Av. Julius Nyerere, to Praca dos Combatentes	322	4,520	2,431	337	627	8,238
				E	Rua de Beira	125	2,683	713	92	271	3,884
				W	Rua de Beira, to the airport	215	3,605	1,771	117	317	6,024
J06	Roads Av Das FPLM, Av 10 De Novembro And Rua Da Soveste	Maputo	Inbound	N	Av 10 de Novembro	103	974	75	9	145	1,305
				S	Rua do Soveste	173	1,670	166	18	159	2,186
				E	Av das FPLM	361	7,148	3,151	203	557	11,420
				W	Av das FPLM, to Praca dos Herois	379	7,965	3,421	181	457	12,403
			Outbound	N	Av 10 de Novembro	202	1,195	325	25	216	1,964
				S	Rua do Soveste	138	1,927	69	21	136	2,291
				E	Av das FPLM	422	7,805	3,421	195	474	12,317
				W	Av das FPLM, to Praca dos Herois	255	6,844	2,998	172	489	10,759
J07	Roads Av Vladimir Lenine, Av Joaquim Chissano And	Av Kenneth Kaunda - Maputo	Inbound	N	Av Vladimir Lenine	505	8,665	4,705	187	342	14,404
				S	Av Vladimir Lenine, to Baixa	492	6,740	2,629	142	283	10,285
				E	Av Kenneth Kaunda, to Costa do Sol	381	10,264	1,922	197	555	13,319
				W	Av Joaquim Chissano	546	10,584	3,162	74	781	15,147
			Outbound	N	Av Vladimir Lenine	371	6,519	3,494	129	205	10,719
				S	Av Vladimir Lenine, to Baixa	557	9,131	3,781	114	521	14,103
				E	Av Kenneth Kaunda, to Costa do Sol	622	11,277	3,023	182	637	15,741
				W	Av Joaquim Chissano	366	9,339	2,105	170	584	12,565
J08	Av Marginal	Maputo		n/a	Costa Do Sol-Baixa	207	4,384	165	2	98	4,857
				n/a	Costa Do Sol-Baixa	61	4,216	208	2	38	4,526
J09	Roads Av Da OUA, Av Da ONU, Av 24 De Julho And Rua Da Toyota	Maputo	Inbound	N	Rua da Toyota	185	2,882	1,228	147	310	4,751
				S	Av da ONU	181	7,950	2,207	118	650	11,107
				E	Av 24 de Julho	246	6,631	2,615	229	346	10,067
				W	Av da OUA	358	13,769	3,404	422	993	18,945
			Outbound	N	Rua da Toyota	184	3,651	961	51	308	5,155
				S	Av da ONU	262	8,410	1,314	137	825	10,948
				E	Av 24 de Julho	217	8,665	2,781	380	254	12,297
				W	Av da OUA	307	10,510	4,396	351	917	16,481

At		In	Inbound/ Outbound	Arm		Bicycle & Motorcycle	Car & Taxi	Chapa & Minibus	Bus & Coach	Truck	Total
J10	Roads Av Joaquim Chissano And Av Acordos De Lusaka	Maputo	Inbound	N	Av Accordos de Lusaka, to airport	486	10,532	3,360	222	712	15,311
				S	Av Accordos de Lusaka, to Shoprite	352	9,426	4,191	243	459	14,672
				E	Av Joaquim Chissano, to OMM Roundabout	369	11,389	1,619	21	783	14,181
				W	Av Joaquim Chissano, to Jardim	518	10,083	1,721	86	750	13,158
			Outbound	N	Av Accordos de Lusaka, to airport	294	7,437	4,730	224	824	13,509
				S	Av Accordos de Lusaka, to Shoprite	352	9,785	3,498	245	735	14,615
				E	Av Joaquim Chissano, to OMM Roundabout	663	13,800	1,366	63	590	16,483
				W	Av Joaquim Chissano, to Jardim	413	10,464	1,296	41	522	12,736
J11	Roads Av 24 De Julho And Av Guerra Popular	Maputo	Inbound	N	Av Guerra Popular, to the airport	176	4,605	3,503	234	121	8,639
				S	Av Guerra Popular, to Baixa	305	5,695	4,317	663	209	11,189
				E	Av 24 de Julho, to Polana	361	9,468	6,754	390	301	17,274
				W	Av 24 de Julho, to Alto Mae	213	6,843	4,066	365	154	11,641
			Outbound	N	Av Guerra Popular, to the airport	337	5,463	4,809	575	136	11,320
				S	Av Guerra Popular, to Baixa	239	5,109	5,808	489	118	11,764
				E	Av 24 de Julho, to Polana	250	8,102	3,190	169	185	11,897
				W	Av 24 de Julho, to Alto Mae	230	7,947	4,863	429	349	13,818
J12	Roads Av 25 De Setembro And Av Guerra Popular	Maputo	Inbound	N	Av Guerra Popular, to airport	244	4,953	1,968	709	158	8,031
				S	Av Guerra Popular, to the port	340	8,847	2,274	586	473	12,520
				E	Av 25 Setembro, to Baixa	295	10,055	1,499	217	362	12,428
				W	Av 25 Setembro, to Matola	275	9,680	1,958	122	541	12,576
			Outbound	N	Av Guerra Popular, to airport	276	4,446	2,401	664	377	8,164
				S	Av Guerra Popular, to the port	187	5,901	1,309	574	164	8,136
				E	Av 25 Setembro, to Baixa	346	11,724	2,711	274	621	15,676
				W	Av 25 Setembro, to Matola	339	11,442	1,273	115	367	13,536
J13	Roads Av Eduardo Mondlane And Av Karl Marx	Maputo	Inbound	N	Av Karl Marx, to Malhangalene	353	7,768	2,629	34	125	10,909
				S	Av Karl Marx, to Baixa	330	9,014	2,763	140	137	12,383
				E	Av Eduardo Mondlane, to Polana	345	13,891	3,957	244	159	18,597
				W	Av Eduardo Mondlane, to Alto Mae	258	11,269	3,343	215	63	15,148
			Outbound	N	Av Karl Marx, to Malhangalene	390	9,012	2,402	52	95	11,951
				S	Av Karl Marx, to Baixa	354	7,482	3,380	43	102	11,361
				E	Av Eduardo Mondlane, to Polana	257	12,033	3,756	311	99	16,457
				W	Av Eduardo Mondlane, to Alto Mae	291	13,423	3,104	222	192	17,232
J14	Machava Socimol			n/a	Machava Socimol-Maputo	192	2,272	1,861	84	542	4,950
				n/a	Machava Socimol-Maputo	164	2,081	2,125	92	365	4,828

Table K.17: Junction Survey Summary Results (24 hour Passengers by Movement)

At		In	Inbound/ Outbound	Arm		Bicycle & Motorcycle	Car & Taxi	Chapa & Minibus	Bus & Coach	Total
J01	Roads N2/ N4 And Av Abel Baptista	Matola	Inbound	N	Road N4, to Ressano Garcia	243	24,703	35,319	12,125	72,390
				S	Av Abel Baptista	141	13,134	9,047	1,470	23,792
				E	Road N4, to Maputo	234	24,212	28,525	14,390	67,361
				W	Road N2, to Boane	141	18,747	25,661	9,700	54,248
			Outbound	N	Road N4, to Ressano Garcia	207	22,364	30,049	8,104	60,724
				S	Av Abel Baptista	158	13,924	6,554	2,727	23,363
				E	Road N4, to Maputo	206	30,817	28,571	16,314	75,907
				W	Road N2, to Boane	198	13,621	34,508	10,755	59,083
J02	Roads Av Eduardo Mondlane/ Av Das Industrias	Matola	Inbound	N	Av Eduardo Mondlane, to Estadio da Machava	198	11,154	26,395	7,649	45,396
				S	Av Eduardo Mondlane, to the tollgate	250	15,062	29,721	7,877	52,909
				E	n/a					
				W	Av das Industrias	147	10,223	19,335	2,866	32,571
			Outbound	N	Av Eduardo Mondlane, to Estadio da Machava	217	12,558	31,888	6,834	51,497
				S	Av Eduardo Mondlane, to the tollgate	205	15,086	23,343	7,789	46,423
				E	n/a					
				W	Av das Industrias	164	8,843	19,166	3,408	31,581
J03	Roads N1 And Av Maria De Lurdes Mutola	Maputo	Inbound	N	Road N1, to Marracuene	273	17,282	56,970	22,482	97,007
				S	Road N1, to Benfica	169	9,367	37,207	16,075	62,817
				E	Av Lurdes Mutola	163	9,223	37,685	10,354	57,425
				W	n/a					
			Outbound	N	Road N1, to Marracuene	244	12,697	48,244	19,043	80,229
				S	Road N1, to Benfica	231	15,037	47,553	21,099	83,920
				E	Av Lurdes Mutola	127	8,119	36,349	8,804	53,399
				W	n/a					
J04	Roads Av Maria De Lurdes Mutola/ Sebastião Marcos Mabote/ Mario Esteves Coluna And Julius Nyerere	Praça Da Juventude - Maputo	Inbound	N	Av Sebastio Marcos Mabote	243	7,501	16,391	11,890	36,025
				S	Av Julius Nyerere	281	11,112	33,048	19,202	63,642
				E	Rua Mario Esteves Coluna	128	5,933	3,039	1,311	10,411
				W	Av Lurdes Mutola	183	7,379	20,515	8,514	36,591
			Outbound	N	Av Sebastio Marcos Mabote	261	9,356	20,460	12,955	43,033
				S	Av Julius Nyerere	311	9,747	23,827	17,297	51,183
				E	Rua Mario Esteves Coluna	49	1,483	3,852	2,876	8,261
				W	Av Lurdes Mutola	218	11,494	24,857	7,789	44,358

At		In	Inbound/ Outbound	Arm		Bicycle & Motorcycle	Car & Taxi	Chapa & Minibus	Bus & Coach	Total
J05	Roads Av Julius Nyerere And Rua Da Beira	Maputo	Inbound	N	Av. Julius Nyerere, to Praca de Juventude	415	12,235	28,986	22,322	63,957
				S	Av. Julius Nyerere, to Praca dos Combatentes	326	7,674	29,508	19,433	56,941
				E	Rua de Beira	161	5,686	4,346	4,087	14,280
				W	Rua de Beira, to the airport	299	9,831	27,732	7,747	45,609
			Outbound	N	Av. Julius Nyerere, to Praca de Juventude	446	11,931	31,336	19,356	63,069
				S	Av. Julius Nyerere, to Praca dos Combatentes	373	9,936	28,818	21,171	60,299
				E	Rua de Beira	144	5,898	8,779	5,753	20,574
				W	Rua de Beira, to the airport	253	7,924	21,835	7,326	37,338
J06	Roads Av Das FPLM, Av 10 De Novembro And Rua Da Soveste	Maputo	Inbound	N	Av 10 de Novembro	119	2,141	965	556	3,781
				S	Rua do Soveste	202	3,671	2,277	1,111	7,260
				E	Av das FPLM	422	15,713	36,171	12,740	65,045
				W	Av das FPLM, to Praca dos Herois	449	17,507	38,738	11,396	68,090
			Outbound	N	Av 10 de Novembro	237	2,628	4,265	1,568	8,698
				S	Rua do Soveste	163	4,236	1,179	1,320	6,898
				E	Av das FPLM	497	17,156	38,656	12,230	68,539
				W	Av das FPLM, to Praca dos Herois	298	15,045	34,052	10,780	60,175
J07	Roads Av Vladimir Lenine, Av Joaquim Chissano And	Av Kenneth Kaunda - Maputo	Inbound	N	Av Vladimir Lenine	594	19,047	56,290	11,752	87,682
				S	Av Vladimir Lenine, to Baixa	578	14,816	31,611	8,937	55,941
				E	Av Kenneth Kaunda, to Costa do Sol	444	22,561	24,380	12,388	59,774
				W	Av Joaquim Chissano	636	23,264	37,373	4,676	65,949
			Outbound	N	Av Vladimir Lenine	438	14,330	41,738	8,097	64,603
				S	Av Vladimir Lenine, to Baixa	647	20,070	45,040	7,173	72,930
				E	Av Kenneth Kaunda, to Costa do Sol	728	24,787	36,425	11,407	73,347
				W	Av Joaquim Chissano	431	20,529	26,339	10,689	57,988
J08	Av Marginal	Maputo		n/a	Costa Do Sol-Baixa	247	9,623	1,923	143	11,936
				n/a	Costa Do Sol-Baixa	72	9,250	2,412	151	11,885
J09	Roads Av Da OUA, Av Da ONU, Av 24 De Julho And Rua Da Toyota	Maputo	Inbound	N	Rua da Toyota	219	6,334	14,891	9,229	30,673
				S	Av da ONU	214	17,475	25,328	7,444	50,461
				E	Av 24 de Julho	289	14,576	30,914	14,367	60,146
				W	Av da OUA	427	30,265	40,665	26,533	97,890
			Outbound	N	Rua da Toyota	217	8,025	11,516	3,201	22,959
				S	Av da ONU	309	18,486	15,489	8,580	42,864
				E	Av 24 de Julho	257	19,047	33,326	23,865	76,494
				W	Av da OUA	367	23,102	51,457	22,034	96,960

At		In	Inbound/ Outbound	Arm		Bicycle & Motorcycle	Car & Taxi	Chapa & Minibus	Bus & Coach	Total
J10	Roads Av Joaquim Chissano And Av Acordos De Lusaka	Maputo	Inbound	N	Av Accordos de Lusaka, to airport	559	23,150	38,393	13,965	76,066
				S	Av Accordos de Lusaka, to Shoprite	414	20,719	47,999	15,277	84,409
				E	Av Joaquim Chissano, to OMM Roundabout	425	25,034	18,629	1,345	45,432
				W	Av Joaquim Chissano, to Jardim	614	22,164	20,108	5,385	48,271
			Outbound	N	Av Accordos de Lusaka, to airport	343	16,348	53,778	14,055	84,523
				S	Av Accordos de Lusaka, to Shoprite	414	21,509	40,043	15,414	77,380
				E	Av Joaquim Chissano, to OMM Roundabout	771	30,335	16,191	3,968	51,264
				W	Av Joaquim Chissano, to Jardim	482	23,001	15,090	2,548	41,121
J11	Roads Av 24 De Julho And Av Guerra Popular	Maputo	Inbound	N	Av Guerra Popular, to the airport	210	10,122	40,245	14,728	65,305
				S	Av Guerra Popular, to Baixa	362	12,519	50,596	41,629	105,106
				E	Av 24 de Julho, to Polana	431	20,812	77,207	24,490	122,940
				W	Av 24 de Julho, to Alto Mae	254	15,041	46,640	22,928	84,863
			Outbound	N	Av Guerra Popular, to the airport	404	12,009	56,047	36,129	104,588
				S	Av Guerra Popular, to Baixa	285	11,230	66,724	30,752	108,993
				E	Av 24 de Julho, to Polana	298	17,810	36,686	10,599	65,392
				W	Av 24 de Julho, to Alto Mae	273	17,468	55,573	26,947	100,261
J12	Roads Av 25 De Setembro And Av Guerra Popular	Maputo	Inbound	N	Av Guerra Popular, to airport	291	10,886	23,546	44,564	79,288
				S	Av Guerra Popular, to the port	405	19,446	26,505	36,817	83,173
				E	Av 25 Setembro, to Baixa	349	22,102	17,581	13,622	53,654
				W	Av 25 Setembro, to Matola	328	21,277	23,026	7,643	52,273
			Outbound	N	Av Guerra Popular, to airport	326	9,774	27,819	41,705	79,624
				S	Av Guerra Popular, to the port	223	12,972	15,541	36,094	64,829
				E	Av 25 Setembro, to Baixa	411	25,771	32,176	17,232	75,590
				W	Av 25 Setembro, to Matola	404	25,151	15,044	7,221	47,819
J13	Roads Av Eduardo Mondlane And Av Karl Marx	Maputo	Inbound	N	Av Karl Marx, to Malhangalene	423	17,074	29,538	2,137	49,171
				S	Av Karl Marx, to Baixa	391	19,814	37,400	8,784	66,390
				E	Av Eduardo Mondlane, to Polana	411	30,533	58,409	15,334	104,688
				W	Av Eduardo Mondlane, to Alto Mae	306	24,771	45,488	13,483	84,047
			Outbound	N	Av Karl Marx, to Malhangalene	466	19,809	27,066	3,284	50,625
				S	Av Karl Marx, to Baixa	422	16,446	37,760	2,671	57,300
				E	Av Eduardo Mondlane, to Polana	306	26,450	55,887	19,539	102,182
				W	Av Eduardo Mondlane, to Alto Mae	345	29,504	49,069	13,920	92,838
J14	Machava Socimol			n/a	Machava Socimol–Maputo	223	4,991	21,857	5,263	32,335
				n/a	Machava Socimol–Maputo	187	4,573	24,742	5,806	35,308

K.7 Public Transport Surveys

K.7.1 Purpose and Objectives

Surveys were conducted at four terminals in order to identify:

- Routes operating from these terminals, including the number of chapas serving each route
- Number of one-way trips operated by each vehicle on the surveyed day
- Frequency of chapa departures from terminals, by time of day
- The number of chapas waiting at terminals, by time of day
- Number of passengers arriving at and departing from terminals, by time of day

K.7.2 Survey Locations and Methodology

The surveyed terminals were:

- Museu (Maputo);
- Xipamanine (Maputo);
- Zimpeto (Maputo); and,
- Liberdade (Matola).

Arriving and departing chapas were recorded at each terminal, including the time of arrival/ departure, the route, the vehicle's number plate and size. In addition, passengers were counted boarding and alighting.

K.7.3 Results and Analysis

(1) Chapa Routes Operating from Each Terminal and Vehicles on Route

Given that chapas were recorded based *inter alia* on their number plates, it was possible to calculate the number of chapa vehicles operating to/from each of the surveyed terminals, as shown in Table K.18.

Table K.18: Number of Chapas Operating To/From Each Terminal Surveyed

Terminal	<=15 seats	Truck/ PickUp	16–28 seats	>28 seats	Total
Museu	241	19	260	57	577
Zimpeto	488	32	62	59	641
Xipamanine	552	16	14	1	583
Liberdade	264	4	12	10	290

In addition, the numbers of chapa operating on each route to/from each terminal were also calculated. These data are given in Table K.19 (Museu), Table K.20 (Zimpeto), Table K.21 (Xipamanine) and Table K.22 (Liberdade). Note that because in practice some chapas switch routes during the day (especially the informal truck/ pick-up (*"caixa aberta"*), the totals given in Table K.18 may be different from the totals given in the other tables in this sub-section.

Table K.19: Number of Chapas Operating To/From Museu Terminal, by Route

	Inbound (Arrivals)					Outbound (Departures)				
Route	**<=15 seats**	**Truck/ PickUp**	**16–28 seats**	**>28 seats**	**Total**	**<=15 seats**	**Truck/ PickUp**	**16–28 seats**	**>28 seats**	**Total**
Acipol	0	0	0	4	4	1	0	0	5	6
Agostinho Neto	0	0	4	0	4	0	0	5	0	5
Albazine	0	0	2	2	4	1	0	3	4	8
Anjo Voador	1	0	0	0	1	0	0	0	0	0
Benfica	3	0	56	0	59	3	2	63	1	69
Boane	0	0	0	0	0	1	0	0	0	1
Cinema 700	3	0	0	2	5	4	0	0	1	5
CMC	0	0	0	0	0	0	0	0	2	2
Drive-In	0	0	0	0	0	0	0	1	0	1
Hulene	37	0	1	0	38	33	1	6	0	40
Khongolote	0	0	0	1	1	0	0	0	1	1
Laulane	16	1	1	1	19	16	0	1	1	18
Machava	0	0	0	1	1	0	0	0	0	0
Machava Socimol	3	0	0	3	6	2	0	0	5	7
Magoanine	5	1	17	3	26	2	0	22	8	32
Magoanine CMC	0	0	0	3	3	0	0	0	0	0
MagoanineVila Poca	0	0	0	1	1	0	0	0	0	0
Mahotas	0	0	0	2	2	0	0	0	1	1
Malhampsene	0	0	0	1	1	0	0	0	2	2
Malhazine	2	0	27	1	30	2	1	35	3	41
Marracuene	0	0	0	1	1	0	0	0	1	1
Massinga	1	0	0	0	1	0	0	0	0	0
Matendene	0	0	1	2	3	1	0	5	5	11
Matola 700	1	0	0	0	1	0	0	0	0	0
Matola Cidade	1	0	0	0	1	0	0	0	2	2
Matola Fomento	9	0	1	1	11	12	1	0	1	14
Michafutene	1	0	3	0	4	0	0	3	0	3
Missão Roque	7	0	61	0	68	2	0	71	2	75
Mozal	0	0	1	0	1	2	0	1	1	4
Patrice Lumumba	31	0	4	1	36	33	0	3	3	39
Polana	0	0	0	1	1	0	0	0	0	0
Ponto Final	0	0	0	3	3	0	0	1	11	12
Praça dos Combatentes	0	0	0	1	1	1	6	0	2	9
T3	23	0	1	1	25	24	0	0	1	25
Xiquelene	2	11	0	0	13	0	0	0	0	0
Zona Verde	3	0	12	1	16	0	0	18	0	18
Liberdade	19	0	1	2	22	25	0	4	6	35
Xipamanine	68	0	2	1	71	58	0	2	0	60
Zimpeto	2	0	12	7	21	10	0	33	22	65
TOTAL	238	13	207	47	505	233	11	277	91	612

Table K.20: Number of Chapas Operating To/From Zimpeto Terminal, by Route

	Inbound (Arrivals)					Outbound (Departures)				
Route	<=15 seats	Truck/ PickUp	16–28 seats	>28 seats	Total	<=15 seats	Truck/ PickUp	16–28 seats	>28 seats	Total
Agostinho Neto	0	0	0	0	0	0	0	1	0	1
Albazine	1	0	0	0	1	2	0	0	0	2
Alto Maé	0	0	0	1	1	0	0	0	1	1
Anjo Voador	0	0	1	1	2	17	0	1	2	20
Baixa	2	0	4	13	19	0	0	1	20	21
Benfica	11	0	0	0	11	83	2	1	1	87
Choupal	0	0	0	0	0	1	0	0	0	1
Costa do Sol	3	0	1	1	5	2	2	0	0	4
Expresso	2	1	0	0	3	0	0	0	0	0
Grande Maputo	36	0	0	0	36	33	0	0	0	33
Guava	0	0	0	0	0	0	1	0	0	1
Hulene	1	1	0	0	2	0	0	0	0	0
Jardim	0	0	0	0	0	1	1	1	0	3
Junta	1	0	0	0	1	10	0	1	0	11
Khongolote	1	0	0	0	1	0	0	0	0	0
Laulane	0	1	0	0	1	0	1	0	0	1
Machava Socimol	6	0	0	0	6	6	0	0	0	6
Magoanine	9	0	0	0	9	11	2	0	0	13
Malhampsene	1	0	0	0	1	4	0	0	0	4
Matendene	1	0	0	0	1	0	0	0	0	0
Matola	0	0	0	0	0	3	0	0	0	3
Matola Cidade	8	1	1	1	11	5	0	0	1	6
Michafutene	0	0	0	0	0	7	0	0	0	7
Missão Roque	0	0	0	0	0	0	1	1	0	2
Patrice Lumumba	0	0	0	0	0	6	1	0	0	7
Praça dos Combatentes	119	9	9	4	141	108	6	6	8	128
Praça dos Trabalhadores	1	0	2	11	14	0	0	0	15	15
Singathela	11	0	0	0	11	13	0	0	0	13
Xiquelene	0	0	0	0	0	2	0	0	0	2
Zona Verde	1	0	0	0	1	4	0	0	0	4
Liberdade	4	0	0	0	4	5	0	0	0	5
Museu	10	0	33	22	65	2	0	12	7	21
Xipamanine	61	0	4	0	65	2	0	0	0	2
Total	290	13	55	54	412	327	17	25	55	424

Table K.21: Number of Chapas Operating To/From Xipamanine Terminal, by Route

Route	Inbound (Arrivals) <=15 seats	Inbound Truck/ PickUp	Inbound 16–28 seats	Inbound >28 seats	Inbound Total	Outbound (Departures) <=15 seats	Outbound Truck/ PickUp	Outbound 16–28 seats	Outbound >28 seats	Outbound Total
3 de Fevereiro	1	0	0	0	1	1	0	0	0	1
Agostinho Neto	7	0	0	0	7	8	0	0	0	8
Anjo Voador	97	0	0	0	97	84	0	1	0	85
Baixa	0	0	0	0	0	1	0	0	0	1
Benfica	17	0	0	1	18	27	3	0	0	30
Bobole	3	0	0	0	3	1	0	0	0	1
Hulene	33	1	0	0	34	29	0	0	0	29
Jardim	0	0	0	0	0	1	0	0	0	1
Laulane	13	0	0	0	13	19	0	0	0	19
Liberdade	0	0	0	0	0	0	0	0	0	0
M. Grossista	1	0	0	0	1	0	0	0	0	0
Machava Socimol	24	0	0	0	24	39	1	1	0	41
Magoanine	1	0	0	0	1	0	0	0	0	0
Magude	5	0	0	0	5	10	0	0	0	10
Manduca	0	0	0	0	0	1	0	0	0	1
Manhiça	0	0	0	0	0	1	0	0	0	1
Marracuene	0	0	0	0	0	1	0	0	0	1
Michafutene	30	0	1	0	31	39	0	2	0	41
Missão Roque	7	0	0	0	7	14	0	0	0	14
Patrice Lumumba	29	1	1	0	31	41	1	0	0	42
Praça dos Combatentes	56	0	1	0	57	50	3	1	0	54
T3	17	1	0	0	18	19	1	1	0	21
Zona Verde	28	0	0	0	28	38	0	2	0	40
Museu	58	0	2	0	60	68	0	2	1	71
Zimpeto	2	0	0	0	2	61	0	4	0	65
Total	429	3	5	1	438	553	9	14	1	577

Table K.22: Number of Chapas Operating To/From Liberdade Terminal, by Route

Route	Inbound (Arrivals) <=15 seats	Inbound Truck/ PickUp	Inbound 16-28 seats	Inbound >28 seats	Inbound Total	Outbound (Departures) <=15 seats	Outbound Truck/ PickUp	Outbound 16-28 seats	Outbound >28 seats	Outbound Total
Anjo Voador	36	2	1	0	39	41	0	0	0	41
Benfica	18	0	0	0	18	19	0	0	0	19
Coca-Cola	1	0	0	0	1	1	0	0	0	1
Junta	33	0	1	0	34	34	0	1	0	35
Malhampsene	30	1	0	0	31	20	1	1	0	22
Matola Cidade	51	0	0	0	51	42	0	0	0	42
Patrice Lumumba	0	0	1	0	1	0	1	0	0	1
Praça dos Combatentes	0	0	0	1	1	0	0	0	0	0
Praça dos Trabalhadores	0	0	0	3	3	0	0	0	3	3
UP	0	0	0	0	0	0	0	1	0	1
Museu	25	0	4	6	35	19	0	1	2	22
Xipamanine	0	0	0	0	0	0	0	0	0	0
Zimpeto	5	0	0	0	5	4	0	0	0	4
Total	199	3	7	10	219	180	2	4	5	191

(2) Average Number of One-Way Trips Operated Per Day by Each Vehicle

In addition to the statistics presented in the previous sub-section, collection of data on registration plates also enabled calculation of the number of trips vehicles make on each route on average per day. These outputs are shown in Table K.23.

Table K.23: Average One-Way Trips Operated per Day by Vehicles on Each Route

Route	<=15 seats	Truck/ PickUp	16–28 seats	>28 seats	All
Acipol-Museu	0	0	0	1	1
Agostinho Neto-Museu	0	0	2	0	2
Albazine-Museu	0	0	1	1	2
Anjo Voador-Museu	1	0	0	0	1
Benfica-Museu	2	0	2	0	4
Boane-Museu	0	0	0	0	0
Cinema 700-Museu	1	0	0	1	2
CMC-Museu	0	0	0	0	0
Drive-In-Museu	0	0	0	0	0
Hulene-Museu	4	0	1	0	5
Khongolote-Museu	0	0	0	1	1
Laulane-Museu	3	1	1	2	7
Machava-Museu	0	0	0	1	1
Machava Socimol-Museu	1	0	0	2	3
Magoanine-Museu	2	1	3	1	7
Magoanine CMC-Museu	0	0	0	1	1
MagoanineVila Poca-Museu	0	0	0	1	1
Mahotas-Museu	0	0	0	2	2
Malhampsene-Museu	0	0	0	1	1
Malhazine-Museu	1	0	2	1	4
Marracuene-Museu	0	0	0	1	1
Massinga-Museu	1	0	0	0	1
Matendene-Museu	0	0	1	2	3
Matola 700-Museu	1	0	0	0	1
Matola Cidade-Museu	1	0	0	0	1
Matola Fomento-Museu	3	0	1	2	6
Michafutene-Museu	1	0	1	0	2
Missão Roque-Museu	1	0	2	0	3
Mozal-Museu	0	0	2	0	2
Patrice Lumumba-Museu	3	0	1	2	6
Polana-Museu	0	0	0	1	1
Ponto Final-Museu	0	0	0	1	1
Praça dos Combatentes-Museu	0	0	0	3	3
T3-Museu	3	0	2	1	6
Xiquelene-Museu	1	1	0	0	2
Zona Verde-Museu	1	0	2	1	4
Museu-Acipol	1	0	0	3	4
Museu-Zimpeto	1	0	2	2	5
Museu-Xipamanine	2	0	1	0	3
Museu-Liberdade	2	0	1	2	6
Zimpeto-Museu	1	0	2	3	5
Zimpeto-Xipamanine	2	0	0	0	2
Zimpeto-Liberdade	3	0	0	0	3
Xipamanine-Museu	4	0	1	1	6
Xipamanine-Zimpeto	2	0	1	0	3
Xipamanine-Liberdade	0	0	0	0	0
Liberdade-Museu	3	0	5	1	9
Liberdade-Zimpeto	2	0	0	0	2
Liberdade-Xipamanine	0	0	0	0	0
Average all routes	**53**	**3**	**37**	**42**	**135**

(3) Vehicle Arrivals and Departures through the Day at Each Terminal

The number of vehicles arriving at and departing from each terminal throughout the day are shown in Figure K.21 (Museu), Figure K.22 (Zimpeto), Figure K.23 (Xipamanine) and Figure K.24 (Liberdade). Note that surveys of arriving vehicles and passengers at Xipamanine were not undertaken from 1400 hours onwards.

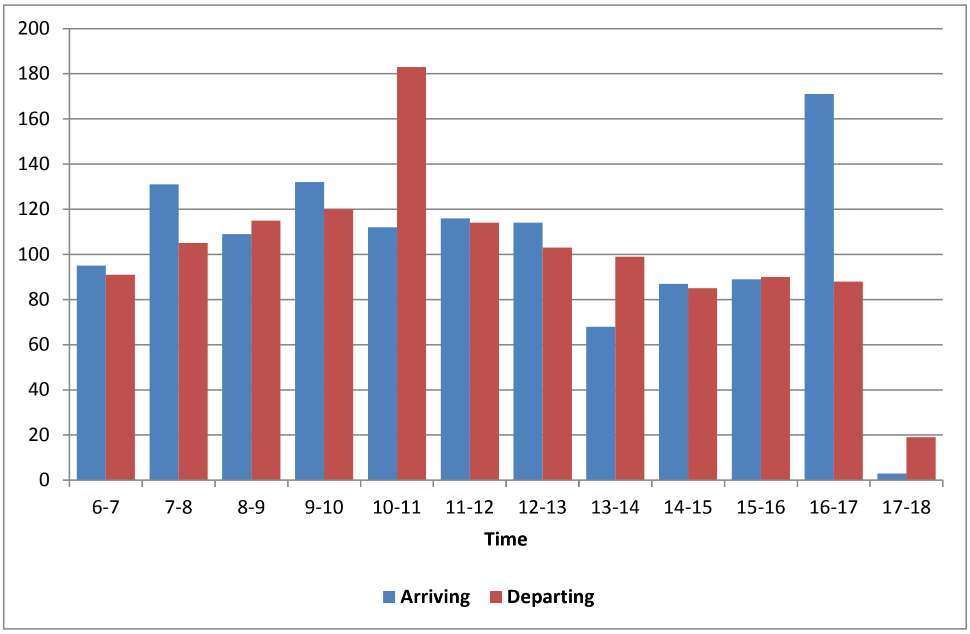


Figure K.21: Vehicle Arrivals and Departures per Hour: Museu

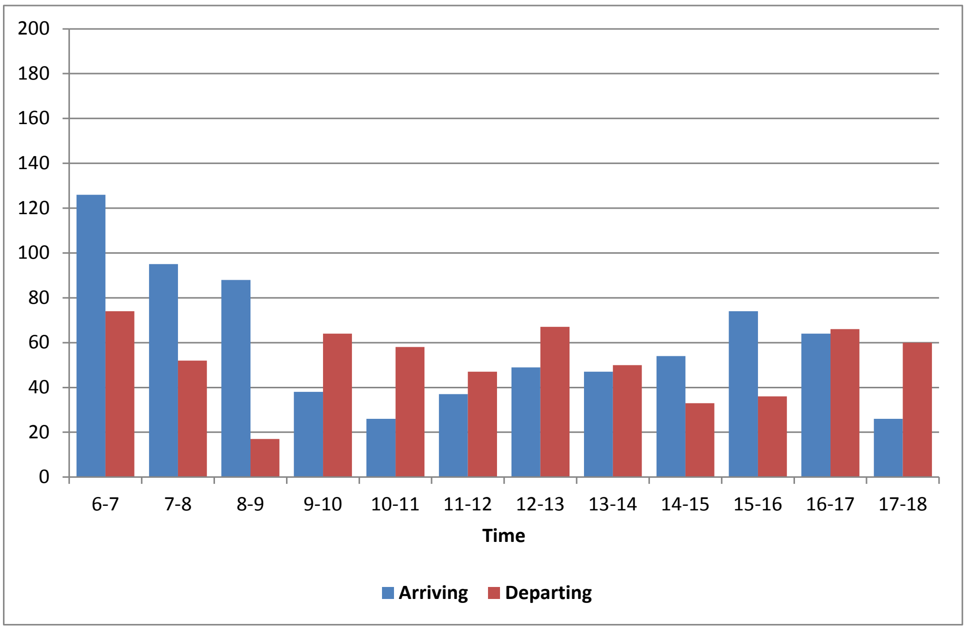


Figure K.22: Vehicle Arrivals and Departures per Hour: Zimpeto

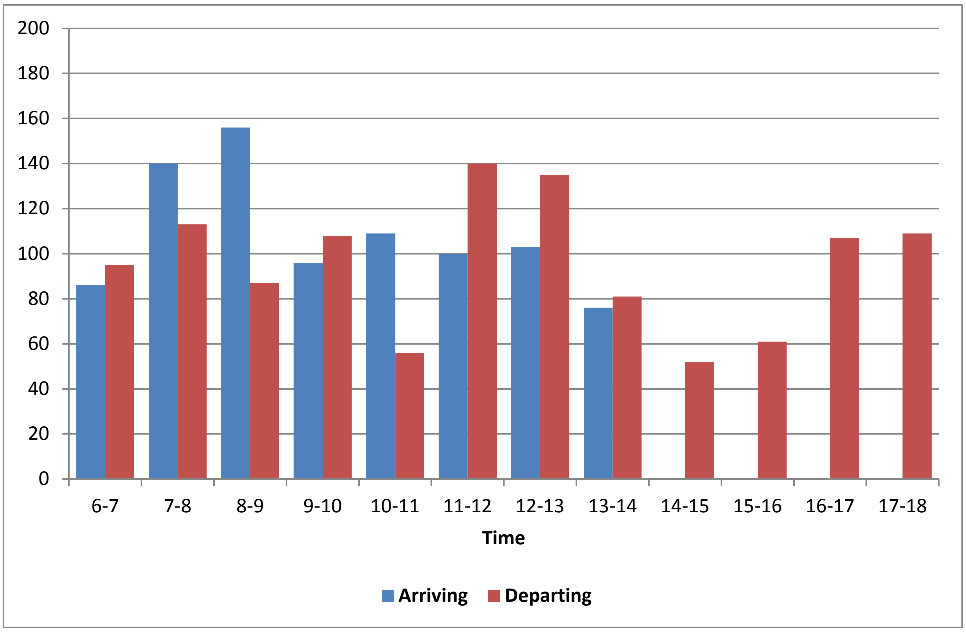


Figure K.23: Vehicle Arrivals and Departures per Hour: Xipamanine

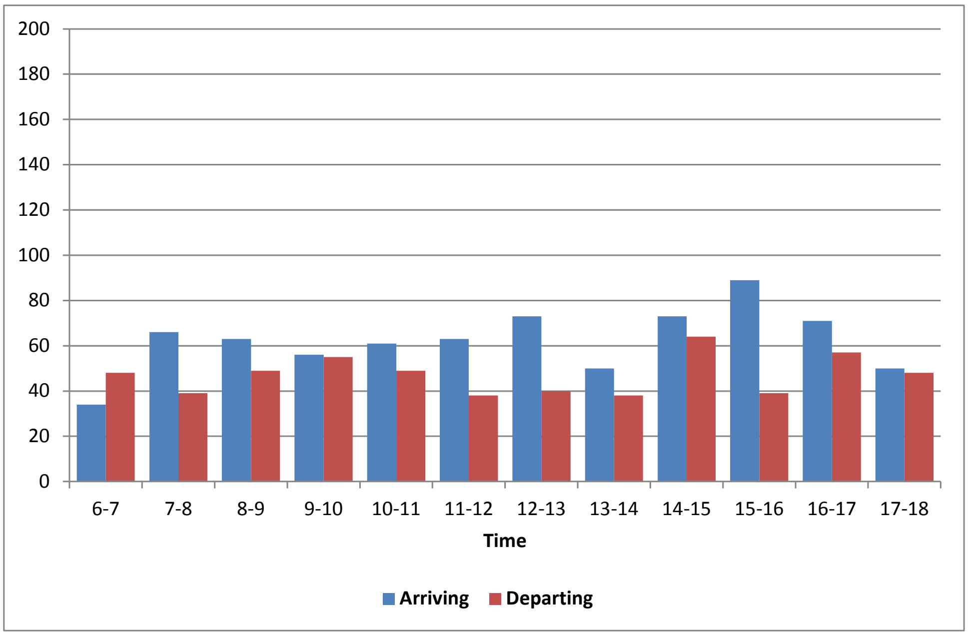


Figure K.24: Vehicle Arrivals and Departures per Hour: Liberdade

(4) Passenger Arrivals and Departures through the Day at Each Terminal

The number of passengers arriving at and departing from each terminal throughout the day are shown in Figure K.25 (Museu), Figure K.26 (Zimpeto), Figure K.27 (Xipamanine) and Figure K.28 (Liberdade). Note that surveys of arriving vehicles and passengers at Xipamanine were not undertaken from 1400 hours onwards.

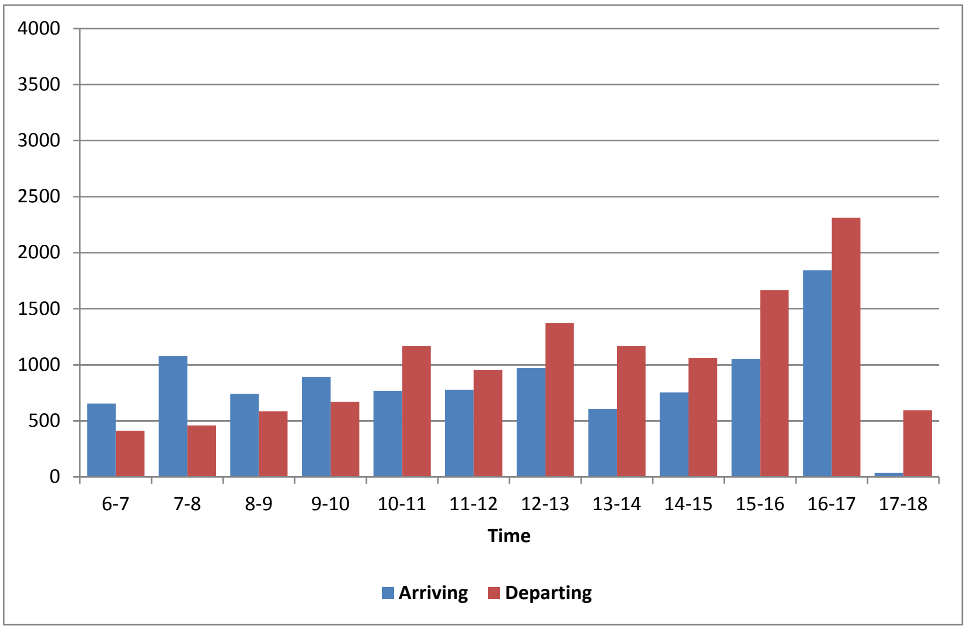


Figure K.25: Passenger Arrivals and Departures per Hour: Museu

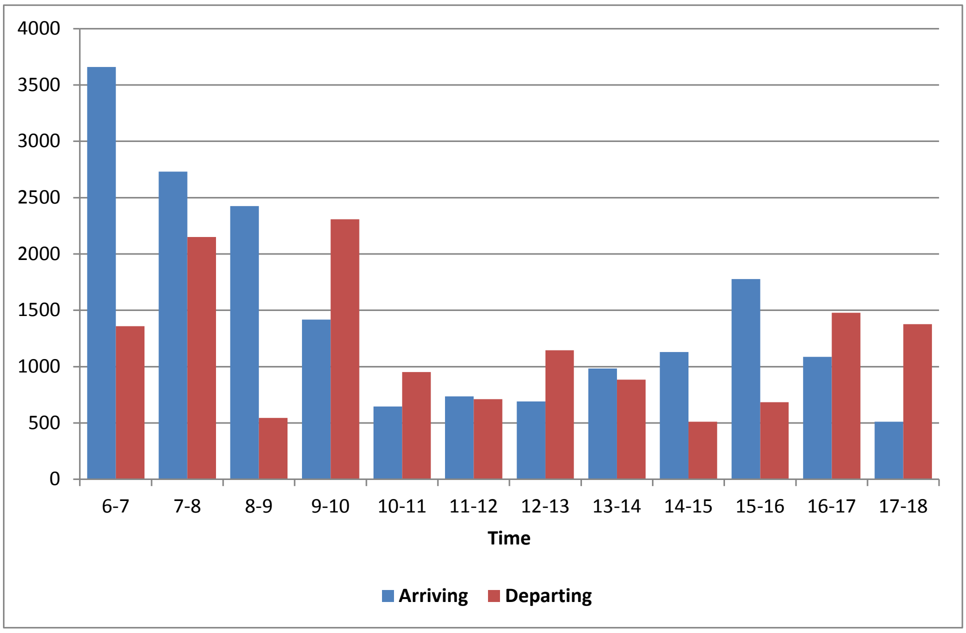


Figure K.26: Passenger Arrivals and Departures per Hour: Zimpeto

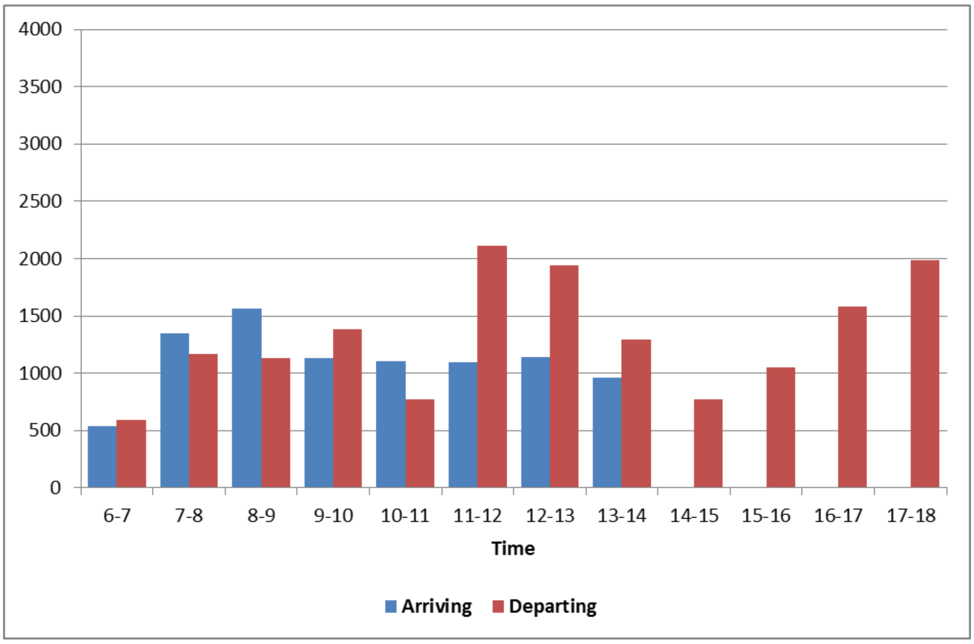


Figure K.27: Passenger Arrivals and Departures per Hour: Xipamanine

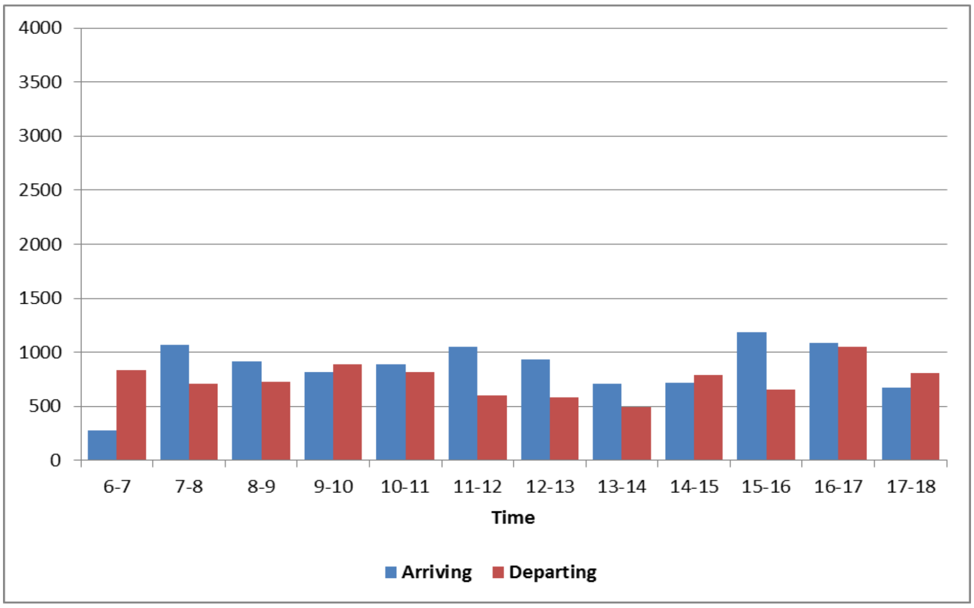


Figure K.28: Passenger Arrivals and Departures per Hour: Liberdade

(5) Average Vehicle Occupancies of Chapas Arriving at and Departing from Terminals

Based upon the data presented in (3) and (4), average vehicle occupancies of arriving and departing chapas were calculated. These are shown in Figure K.29 (Museu), Figure K.30 (Zimpeto), Figure K.31 (Xipamanine) and Figure K.32 (Liberdade). Note that surveys of arriving vehicles and passengers at Xipamanine were not undertaken from 1400 hours onwards.

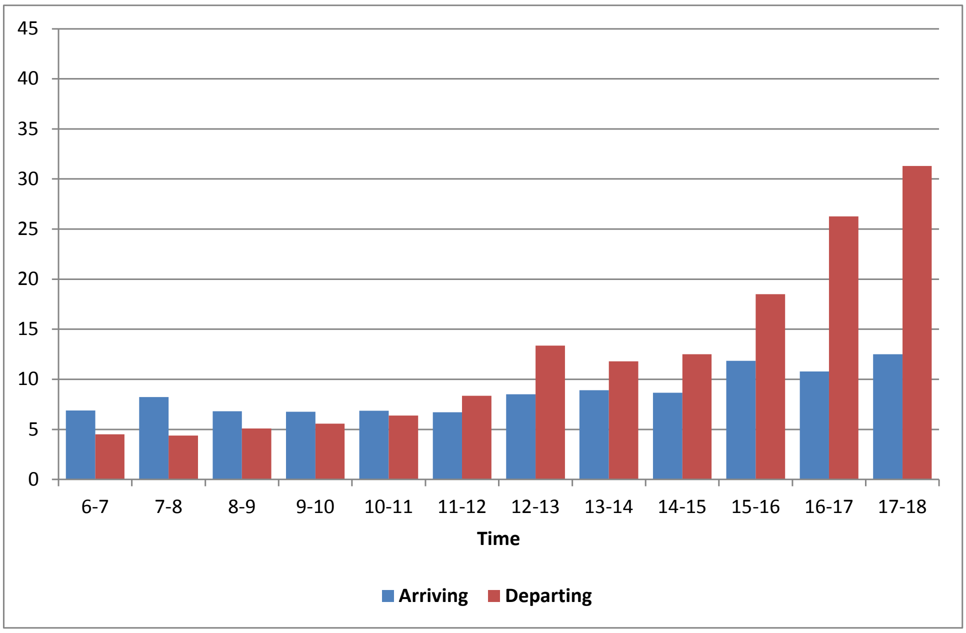


Figure K.29: Average Chapa Occupancies per Hour: Museu

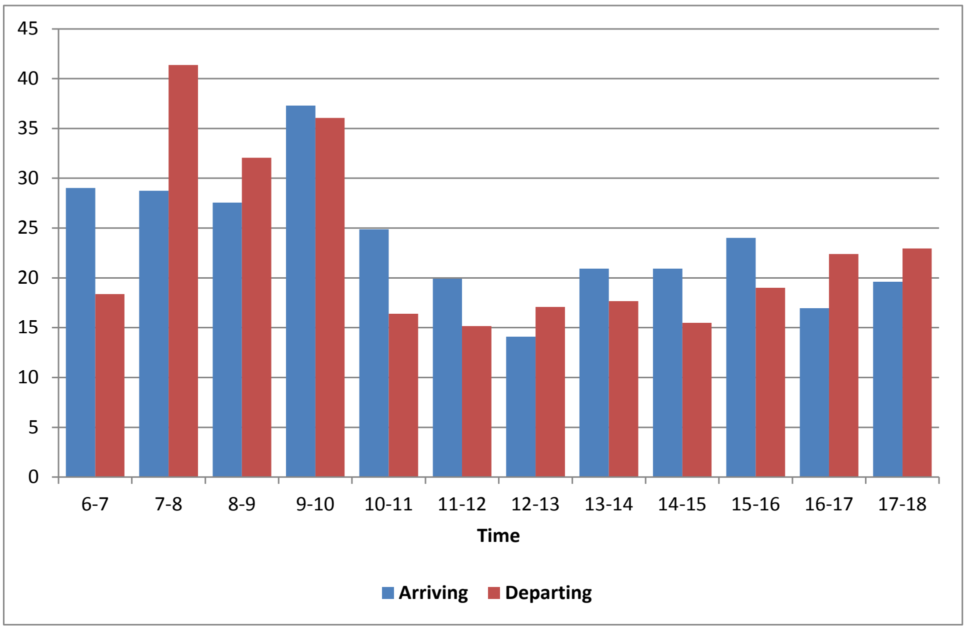


Figure K.30: Average Chapa Occupancies per Hour: Zimpeto

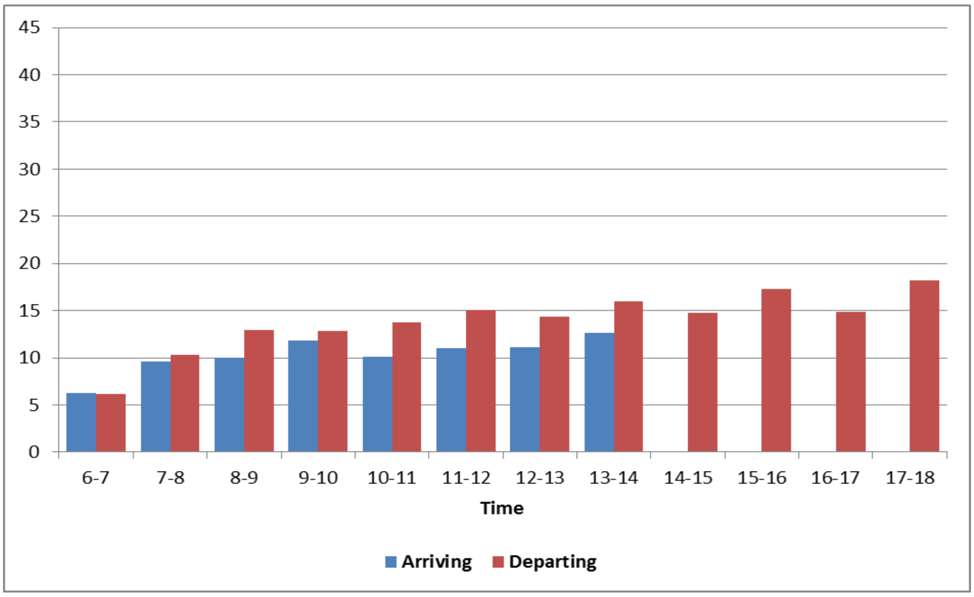


Figure K.31: Average Chapa Occupancies per Hour: Xipamanine

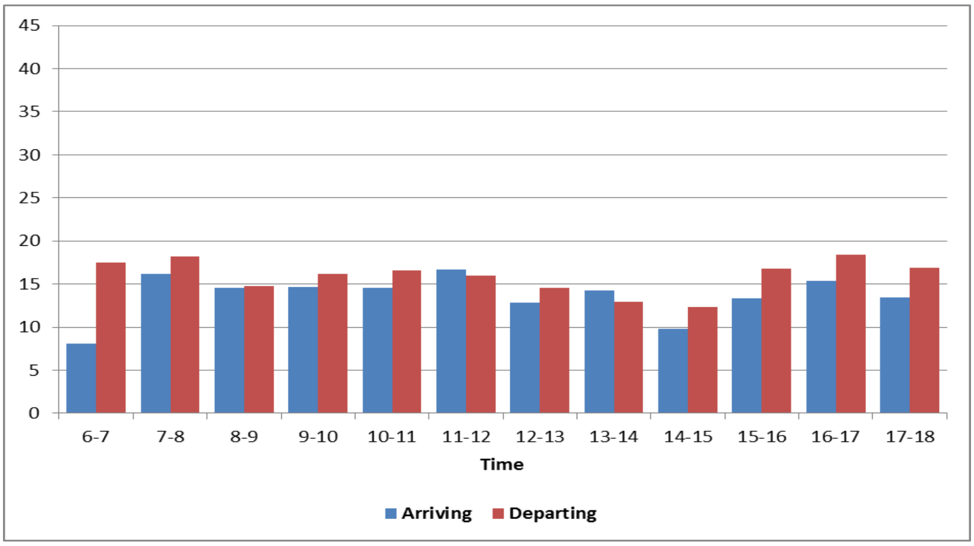


Figure K.32: Average Chapa Occupancies per Hour: Liberdade

K.8 Stated Preference Surveys

K.8.1 Purpose and Objectives

The Stated Preference (SP) surveys are intended to test likely reactions of bus users to new transit systems, namely Bus Rapid Transit.

K.8.2 Survey Methodology

Surveyors interview bus users, first explaining the key characteristics of the alternative transit system, making use of visuals, as shown in Figure K.33.

800 interviews were conducted at bus terminals. The interview sheets are shown in Figure K.34 and Figure K.35.

<Explanation of the BRT/LRT>

BRT: Bus Rapid Transit

LRT: Light Railway Transit

<Characteristics of BRT/LRT >

- Exclusive lane or rail .
  ⇒Regardless of traffic congestion, it can run by fixed speed.
- Large capacity
  ⇒Public transport vehicles decrease in number and traffic congestion is reduced.
- Comfortable and Safety inside vehicles with air-conditioned
  ⇒It will become moving to office ,to school and to home comfortably and safety.

Example Route of BRT/LRT In Msputo

Baixa ⇒ Benfia 16Km

In Evening peak

- Present
  75~90 min.
- BRT/LRT
  40 min

Figure K.33: Visual Explanation of BRT and LRT

Type1 For Chapa/Bus users **No____**

Interview survey of stated preference survey for BRT/LRT

Q1: About your personal attribute.

Age	1. −10 2. 11−20 3. 21−30 4. 31−40 5. 41−50 6. 51−60 7. Above 60
Gender	1. Male 2. Female
Address	1.Maputo 2.Matola 3.Maracuene 4.Boane
Driving license	1. Yes 2.No
Number of family own	･Bicycle ･Motorcycle ･Passenger Car ･Small Truck ･Truck
Type of Jobs	1. Government 2. Semi Govt./ Public 3. Private Company 4. Retired 5. Unemployed 6. Housewife 7. No response
Income for your family (per month)	1. 0-1,000 MT/ month 2. 1,000 – 5,000 MT/Month 3. 5,000-10,000 MT/ month 4. 10,000-15,000 MT/Month 5. 15,000-20,000 MT/month 6. Over 20,000 MT/month

Q2: Purpose of trip

Purpose of the trip
1. To Work 2. To School for Study 3. On Business / Duty / Work 4. Leisure / Recreation 5. To Home 6.Other purpose

【Only for the person who don't own a motorcycle. 】

Q3: Attractiveness to consumers of Motorcycle

Q3-1:If an income increases, is there any hope which buys a motorcycle?
1. Yes 2. No( )

Q3-2 How many incomes increasing?	
1. 1.2 times of the present condition	2. 1.5 times of the present condition
3. 2.0 times of the present condition	4. 2.5 times of the present condition
5. 3.0 times of the present condition	6. 3.5 times of the present condition
7. 4.0 times of the present condition	8. 4.0 times more of the present condition

Figure K.34: Bus User Interview Sheet #1

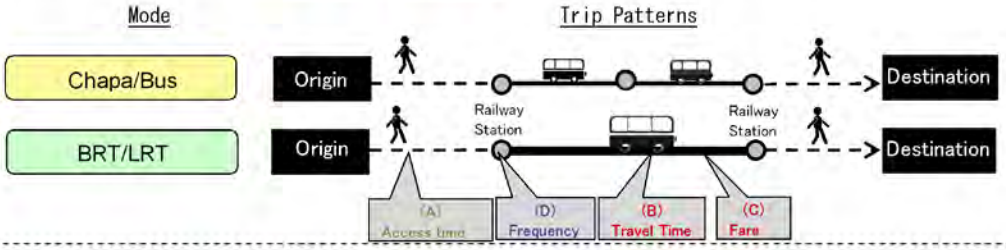
Type1 For Chapa/Bus users No___

Question4: Stated Preference on use of BRT/LRT

In this question, hypothetical situation of implementation of BRT/LRT is assumed.

Hypothetical situation

- BRT/LRT is supported to be implemented.
- Available modes are Chapa/Bus and BRT/LRT (shown in the following Figure).



Q4: Please answer nine binary comparisons shown in the following (①~⑨) with considering level of services of each mode

Question No.	Mode	(A) Access time	(B) Travel Time (Include transfer time)	(C) Fare	(D) Frequency	Select either one alternative
①	Chapa/Bus	15 min	45 min	10MT	10 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	30 min	10MT	5 min	2. Choice BRT/LRT
②	Chapa/Bus	30 min	45 min	10MT	15 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	30 min	15MT	10 min	2. Choice BRT/LRT
③	Chapa/Bus	45 min	45 min	10MT	20 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	30 min	20MT	15 min	2. Choice BRT/LRT
④	Chapa/Bus	30 min	90 min	20MT	20 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	45 min	20MT	15 min	2. Choice BRT/LRT
⑤	Chapa/Bus	45 min	90 min	20MT	10 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	45 min	30MT	5 min	2. Choice BRT/LRT
⑥	Chapa/Bus	15 min	90 min	20MT	15 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	45 min	40MT	10 min	2. Choice BRT/LRT
⑦	Chapa/Bus	45 min	120 min	30MT	15 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	45 min	45MT	10 min	2. Choice BRT/LRT
⑧	Chapa/Bus	15 min	120 min	30MT	20 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	45 min	60MT	15 min	2. Choice BRT/LRT
⑨	Chapa/Bus	30 min	120 min	30MT	10 min	1. Choice Chapa/Bus
	BRT/LRT	30 min	45 min	90MT	5 min	2. Choice BRT/LRT

Figure K.35: Bus User Interview Sheet #2

K.8.3 Results and Analysis

(1) Sample Characteristics

The survey sample characteristics for the 800 interviewees were as set-out in the following figures:

- Figure K.36 shows the age distribution
- Figure K.37 shows the proportion holding driving licences
- Figure K.38 shows place of residence
- Figure K.39 shows trip purpose
- Figure K.40 shows vehicle ownership

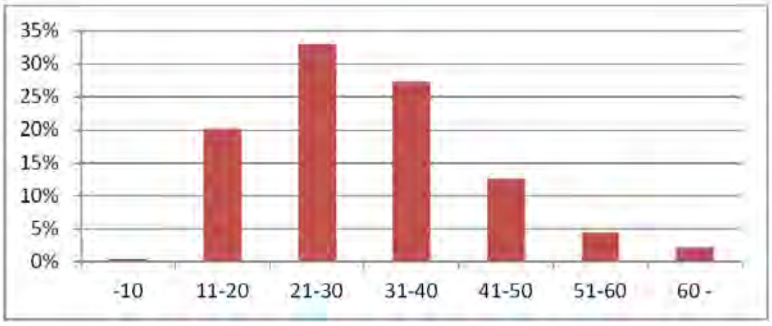


Figure K.36: Age Distribution of Survey Sample

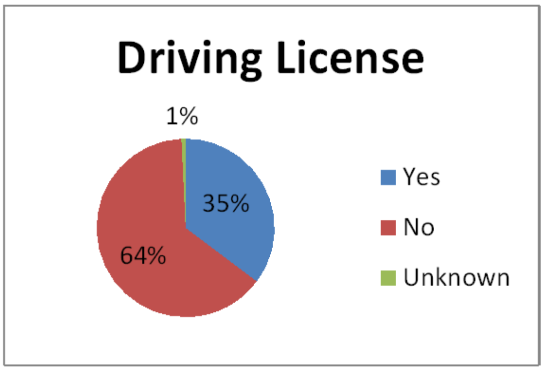


Figure K.37: Proportion of Interviewees Holding Driving Licence

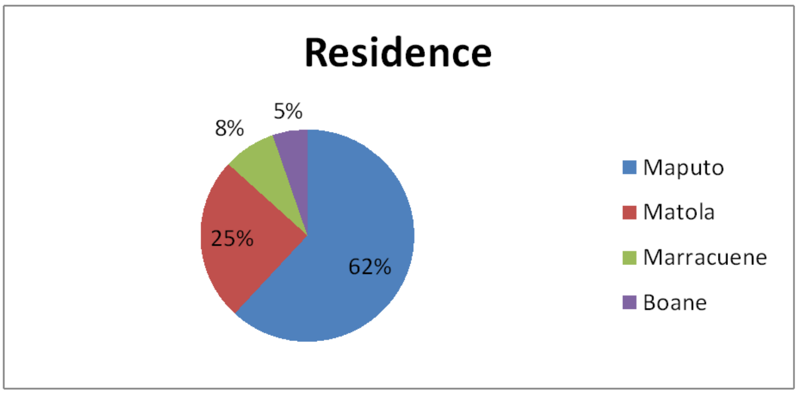


Figure K.38: Location of Interviewee Residences

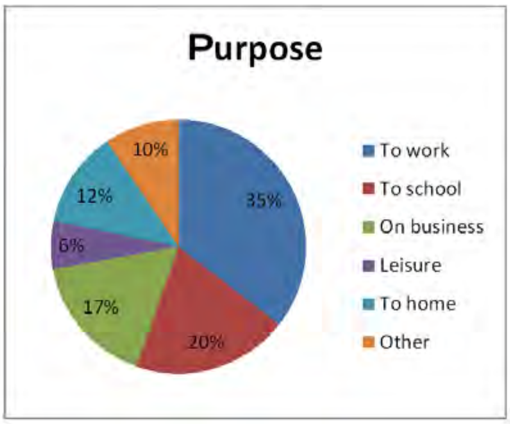
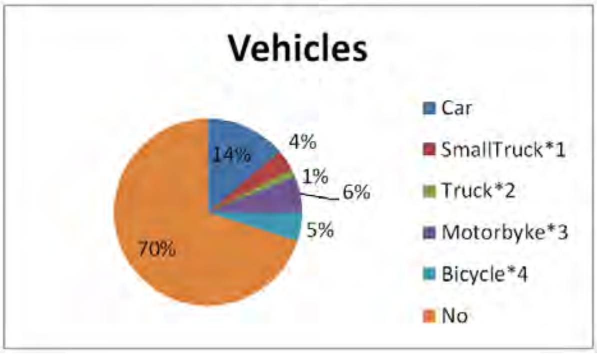


Figure K.39: Trip Purpose



*1: Except Car
*2: Except Car & SmallTruck
*3: Except Car ,SmallTruck & Truck
*4: Except Car ,SmallTruck ,Truck & Motorbyke

Figure K.40: Vehicle Ownership of Survey Sample

(2) Intention about Motorbike Purchase

20% of people who have either only a bicycle or no other means of transportation will want to use a motorcycle if their income increases, as shown in Figure K.41. When income increases 2.5 times, the percentage of those who want to use a motorcycle is 77%, as shown in Figure K.42.

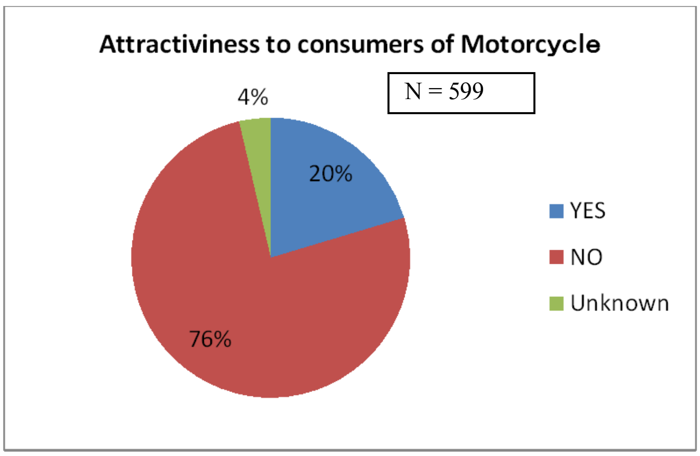


Figure K.41: Attractiveness of Motorcycle Ownership

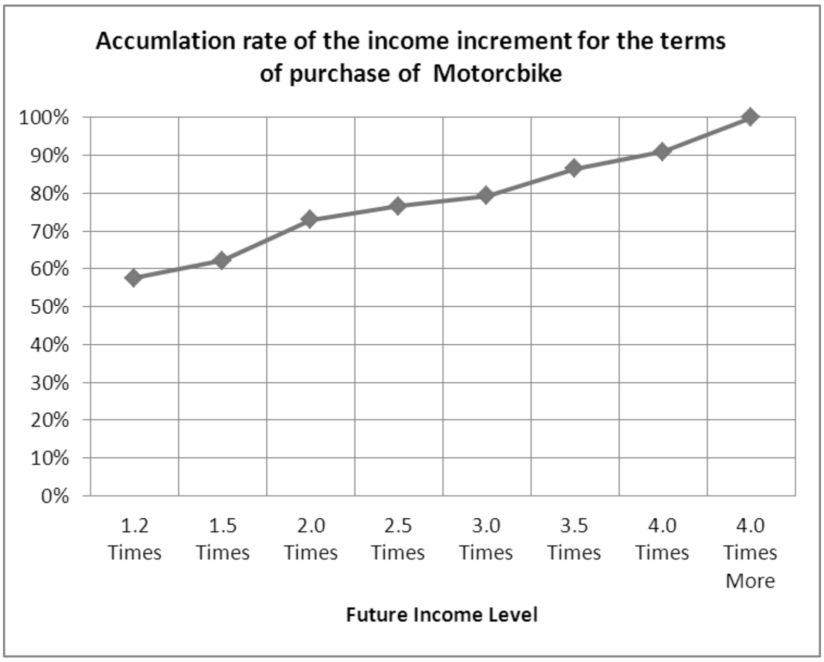


Figure K.42: Attractiveness of Motorcycle Ownership with Respect to Income Growth

(3) Stated Preference Model

The choice probability of each alternative by a paired comparison is as shown in Table K.24 and Figure K.43.

Table K.24: Choice Probability for Each Alternative

	Access Time		Travel Time		Charge		Choice probability	
Alt.	BUS	BRT	BUS	BRT	BUS	BRT	BUS	BRT
1	15	30	45	30	10	10	0.116	0.884
2	30	30	45	30	10	15	0.240	0.760
3	45	30	45	30	10	20	0.405	0.595
4	30	30	90	45	20	20	0.078	0.923
5	45	30	90	45	20	30	0.356	0.644
6	15	30	90	45	20	40	0.559	0.441
7	45	30	120	45	30	45	0.356	0.644
8	15	30	120	45	30	60	0.594	0.406
9	30	30	120	45	30	90	0.660	0.340

Logit model

Vbus＝	0.006251xAccess time−0.00161 × Travel time−0.004785 × Charge−1.38589
Vbrt＝	0.006251xAccess time−0.00161 × Travel time−0.004785 × Charge
Pbrt=	exp(Vbrt)(/exp(Vbrt)+exp(Vbus))

Multiple correlation coefficient		0.813	
	Coefficient	Standard deviation	t -Value
Section	-1.38589	0.56145	-2.468
Access time	0.00625	0.02168	0.288
Travel time	-0.00161	0.01485	-0.108
Charge	-0.04785	0.02057	-2.326

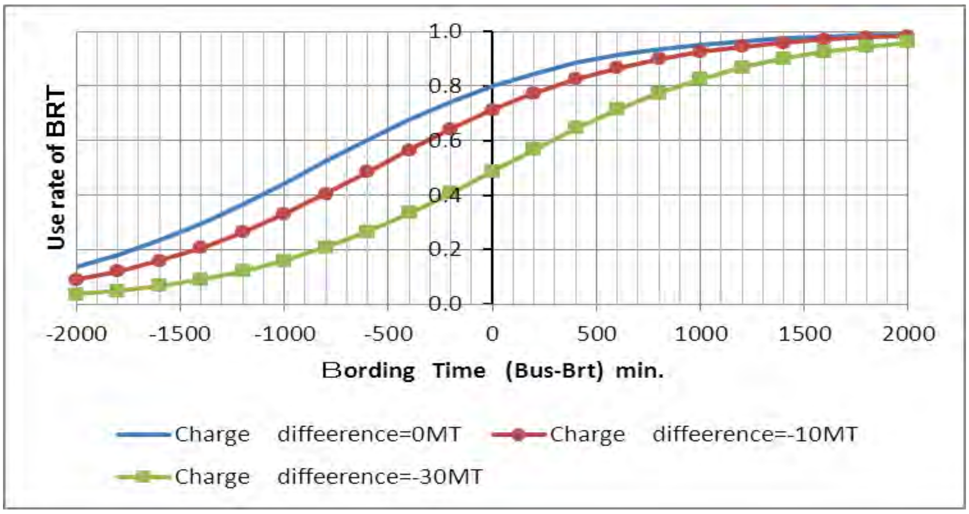


Figure K.43: Logit Model

Technical Report L

Geographic Information System (GIS)

Contents

Figures

Table

Technical Report L Geographic Information System (GIS)

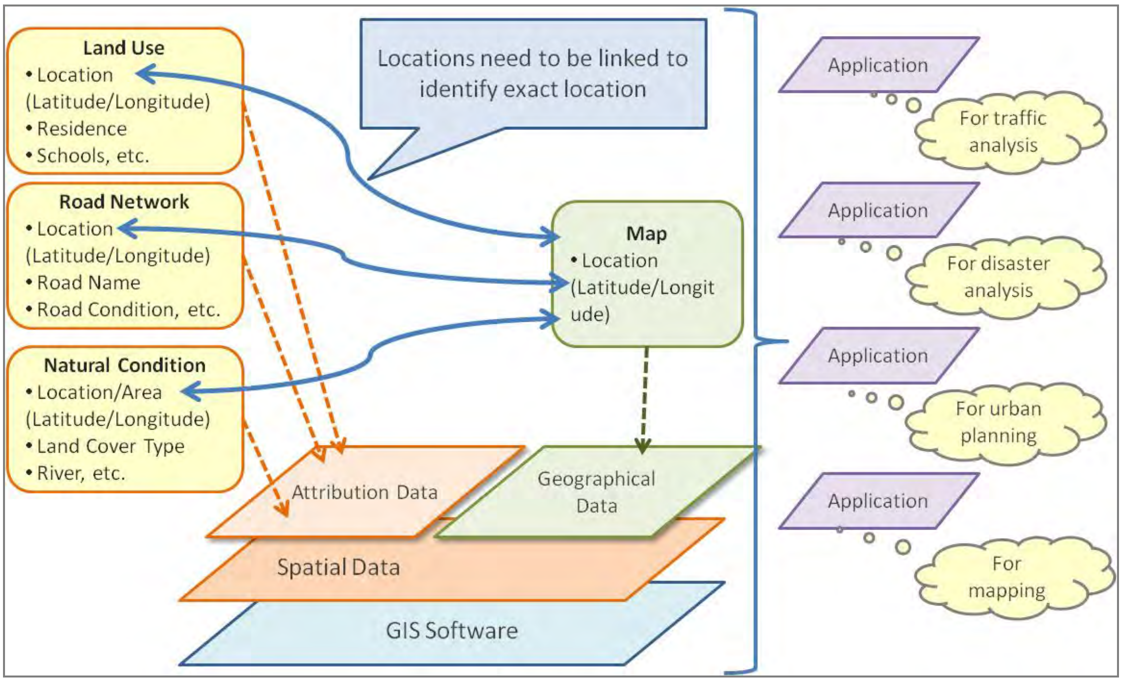
L.1 General Features and Importance of GIS

(1) Introduction

A geographic information system (GIS) enables comprehensive management and modification of spatial data related to geographic information. GIS has been defined as a group of procedures that provide data input, storage and retrieval, mapping, and spatial analysis for both spatial and attribute data to support the decision-making activities of an organization.[1]

A GIS has been developed as a planning tool to support the process of master plan preparation. It enables the visualisation of data and detailed analysis, and provides a tool for decision making. Such systems have been widely used in both the public and private sectors, for policy making, business marketing, and everyday life. As GIS is a key planning tool for urban transport planning, a GIS database is being developed for this project using existing maps and information, as well as information collected during the project.

Figure L.1 shows how the GIS model is being developed for traffic analysis, disaster analysis, and urban planning.



Source: JICA Project Team

Figure L.1: Structure of the GIS

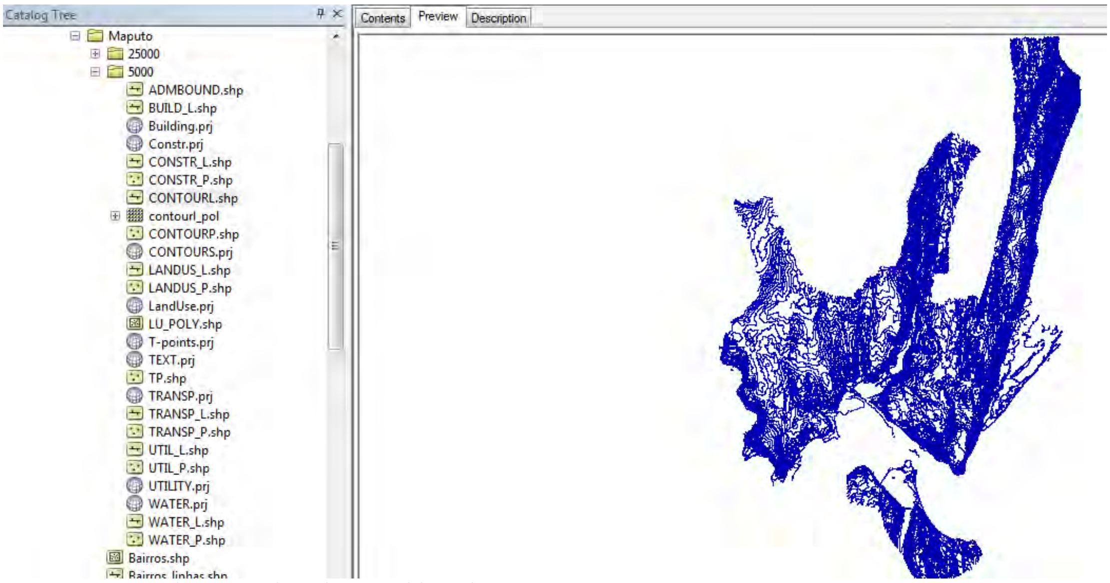
(2) General GIS Features

The GIS tasks for this study include data cleaning, thematic mapping, and spatial analysis of information pertaining to the geographic and spatial context of Greater Maputo. The GIS database developed includes the following classes of data:

[1] David J. Grimshaw, *Bringing Geographical Information Systems into Business*, Longman, Harlow, 1994

- **Boundaries and Basic Data.** For the overall Greater Maputo region the source of data was the national mapping agency, *Centro Nacional de Cartografia e Teledetecção (CENACARTA),* using the *Universal Transversal Mercator (UTM), 36 Zone South; Datum: Moznet; Spheroid: WGS 1984*. The Greater Maputo region includes Maputo Municipality, Matola City, Boane City and Marracuene District. For Maputo Municipality and Matola City, the source of data was the respective municipalities.

- **Topography.** For the general area of the Greater Maputo region, there are altitude data in shape files from 1:250000. However, for the study area, the Shuttle Radar Topography Mission (SRTM) Digital Levitation Model with 90 m spatial resolution is available. Figure L.2 shows the contour lines for Greater Maputo.



Source: JICA Project Team based on World Bank Data Set

Figure L.2: Greater Maputo Contour Lines (Scale 1:5.000)

- **Natural Conditions.** For information on natural conditions, datasets compiled with the support of World Bank in 2000 that include information on most natural conditions were utilized as a base for this study with appropriate updates. The information on natural conditions from the Urban Structure Plans for Maputo Municipality and Matola City were utilized, while for Boane City and Marracuene District information from CENACARTA (scale: 1:50 000) was utilized.

- **Land Use Data.** For Maputo Municipality and Matola City, the source of information was the respective Urban Structure Plans with appropriate updates. For Boane City and Marracuene District, the CENACARTA land use map combined with interpretation of Spot 5 satellite imagery and Google images were used.

- **Transport Network.** To update the existing road network information, the JICA Project Team conducted a road network inventory survey. Figure L.3 shows the Geo-Database of the transport network produced by the JICA Project Team.

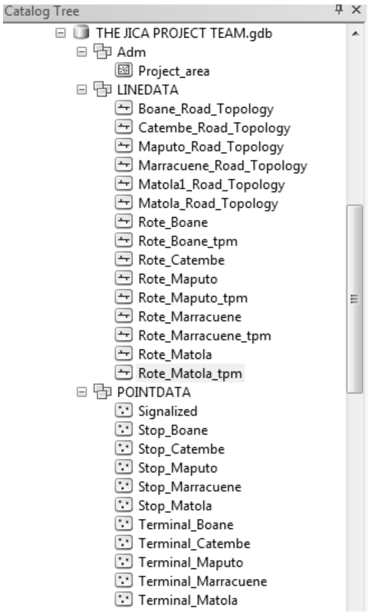


Figure L.3: Geo-Database Produced by the JICA Project Team

- **Public Transport and Transport Modeling.** The spatial data required for this component was collected by the JICA Project Team and integrated into the GIS database. Thematic maps required for the public transport analysis and transport modeling were prepared to support the analysis. Railway data were collected by surveys conducted by the JICA Project Team along the three lines in the Greater Maputo region: Maputo–Marracuene, Maputo–Matola Gare, and Maputo–Boane.

L.2 Data Collection Status and Database Structure

(1) Data Collection Status

Data collection for all the components of the GIS database has been completed as shown in Table L.1.

Table L.1: GIS Data Structure

#	Category	Item	File Type	Status
1	Datum	Determination of Appropriate Coordinate System and Datum	Datum	Done
2	Boundary and Basic Data	Region, Municipality, Ward, Sub-Ward, Census Enumeration Area	Shape (Shp)	Done
3		Census Population, Area (m^2), Population Density (persons/ha) by Boundaries	Shp (Attributes)	Done
4		Major City, Town, Village Location and Name	Point	Done
5		Scanned Urban Area Image with Coordinate System	Jpeg	Done
6	Natural Conditions	Sea Level Contour by 2 m, 10 m, 20 m pitch	Vector	Done
7		Erosion Area	Shp	Done from the urban structure plans
8		Flood River Areas	Shp	Done (wetlands based on Landsat 30 m)
9		Designated Forest Reserve	Shp	Does not exist within the study area
10		Designated Protected Area (Land/Coastal)	Shp	Does not exist within the study area

#	Category	Item	File Type	Status
11		Identified Swampy Area	Shp	Done, vector
12		Soil Condition and Type from Geological Survey Map	Shp	Done, vector
13		River Network	Vector and Shp	Done
14	Topography and 3D Data	Digital Elevation Model		90 m (in raster data)
15		Slope (%) Data (cell size: 200 m × 200 m)		Done, to improve
16		Result of Water Flow Accumulation Analysis for River Network		Done, to improve
17		3D Images of Greater Maputo Region		Done
18		SRTM 90 m DEM Data		Done
19	Land Use and Urban Planning	Existing Land Use Type (e.g., residential, agricultural, institutional, office, commercial, industry	Shp	Done
20		Land Use Plan (Existing Land Use Plan for Maputo and Matola Urban Development (Plan 2007 and necessary updates)	Shp	Done
21		Identified Land Constraint Conditions	Shp	Done, based on Maputo City Master Plan (PEUMM)
22		Unplanned Residential Area	Shp	Done
23		Under Construction and Planned Urban Developments identified by the JICA Project Team	Shp	Done
24	Utility	Utility: Future Water Supply Plan	Vector and Shp	Done, vector and PDF Files
25		Utility: Electrical Supply Network	Vector and Shp	Done, data from Electricidade de Moçambique (EDM)
26	Transport: Road Network	Road Network by Primary, Secondary, and other classes identified start and end point of each link	Vector	Done, based on data from field survey
27		Road Network attributes including road attributes (e.g., paved/unpaved, lanes by direction, sidewalks, distance, central median, used for parking, speed limits, tolls)	Vector (Attributes)	Done, based on data from field survey
28		Road Name and Management Entity (e.g., e. ANE, TRAC)	Vector (Attributes)	Done
29		Traffic Control Movement and Control (e.g., signal lights)	Point	Done
30		Parking Areas	Shp	Done
31	Public Transport	Existing Transportes Públicos de Maputo (TPM) routes including attributes such as ridership, frequency by time of day, fares, and vehicle size, from the JICA Project Team	Vector (Attributes)	Done, based on data from field survey and World Bank data
32		Existing chapa routes including attributes such as ridership, frequency by time of day, fares, and vehicle size, from the JICA Project Team	Vector (Attributes)	Done, based on data from field survey
33		Existing Mozambique Ports and Railways (CFM) routes including attributes such as ridership, frequency by time of day, fares, and vehicle size, from the JICA Project Team	Vector (Attributes)	Done through GPS data collection field work
34		Existing TPM/CFM/chapa terminals and stops from the JICA Project Team	Point	Done, based on data from field survey
35		Taxi Stands	Point	Done
36		Ferry Routes and Terminals	Point and Vector	Done through GPS data collection field work

#	Category	Item	File Type	Status
37	Transport Modeling and Analysis	Origin-destination zones and information from public transport Surveys	Shp (Attributes)	Done, BC Zones
38		Road Network for Network Analysis	Vector	Done
39		Public Services and Transport Network for Network Analysis	Vector	Done
40		Road Network Plan (Target Year, 5-year, 10-year, and 20-year)	Vector	Done
41	Other	City Center Area Detailed AutoCAD Map	Dwg/Dfx	Done
42		Planned Protected Area	Shp	Done; there is no designated protected area in the region
43		Mesh Polygon for Urban Development Constrains Analysis (1 km × 1 km)	Mesh	Done
44		Investments by Development Partners	Attributes	Done
45		Other data entry, processing, and output requested by the Project Team as necessary		Done, based on expert's demands

Source: JICA Project Team

The JICA Project Team has some concerns over the accuracy of the Boane and Marracuene land use data. The capacity of the planning departments of Boane City and Marracuene District does match those of Maputo Municipality and Matola City, and they currently do not have an updated land use plan, As mentioned, due to the lack of a completed city/district land use plan, the CENACARTA land use map combined with Spot 5 satellite imageries interpretation and Google images was used for Boane and Marracuene.

In order to ensure the accuracy of the land use data, a comprehensive land use field survey would be required, and Boane and Marracuene were in the process of finalizing their plans in 2013. Marracuene is currently preparing its district land use plan with the technical support of a consulting firm (DHV Maputo). Authorities of Boane City are conducting a study with support from the Ministry of Environmental Affairs.

(2) Spatial Information Database Structure

All spatial data collected for the study are in shape file (shp.) and AutoCAD (dwg.) format. The data can be viewed, manipulated, and analyzed with ArcGIS software. Figure L.4 shows the GIS data structure.

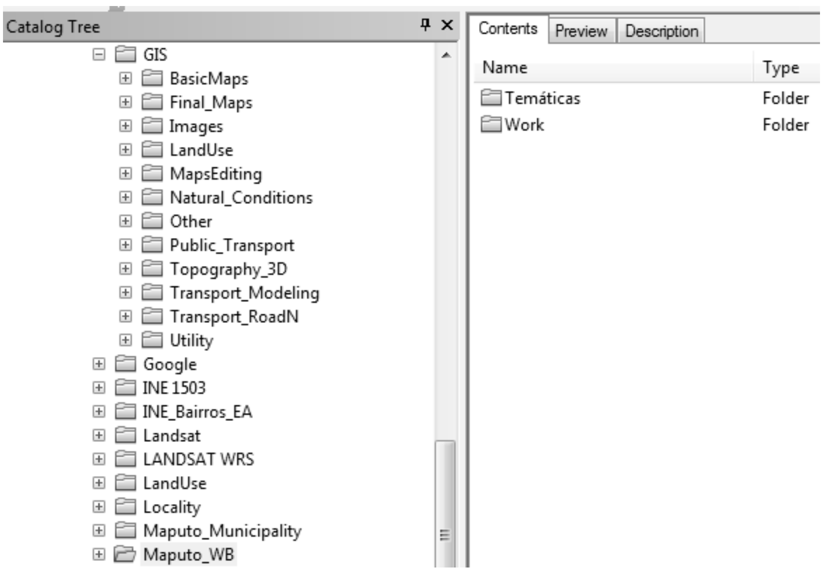


Figure L.4: GIS Data Structure

This database is available in the JICA Project Office located in Maputo and will be handed over to the project counterparts upon completion of the study. The database has been designed to allow for updates of socio-economic and spatial data post project completion, including the land use data from Boane City and Marracuene District, when available.

L.3 Final Remarks

While basic spatial data for Greater Maputo was available, much of the data was not consolidated or up-to-date, requiring the JICA Project Team to spend considerable time collecting, combining, and updating the information and database.

A big challenge for the database development was clarifying administrative limits, especially in Maputo Municipality and Matola City. This problem was resolved by a cooperative effort with the technical officers of the municipalities (administrative boundaries), the National Institute of Statistics (socio-economic data), and the JICA Project Team via numerous technical meetings and working groups. Furthermore, there is a necessity to follow up on the land use plans for Boane and Marracuene.

The GIS database compiles the spatial information for the entire region of Greater Maputo, covering Maputo Municipality, Matola City, Boane City, and Marracuene District, which allow users to perform spatial analysis in the areas of transport, transit, and urban planning beyond municipal and district boundaries. The road network map prepared in this urban master plan is unique in terms of the attributes collected for the entire region. It is recommended that the municipalities and district merge it with the data they have for their own uses. Therefore, it is essential that the GIS database produced in this study to be shared, technically transferred, and continuously updated by the Mozambican counterparts.

Technical Report M

Transport/Traffic Database

Contents

Figures

Table

Technical Report M Transport/Traffic Database

M.1 Introduction

M.1.1 Purpose

As part of the project deliverables, traffic survey data collected, together with the transport model developed will be assembled for handover to DMTT.

M.1.2 Key Components

The key components of the database shall be the following:

- Geographic Information System
- Travel and traffic survey data (see Technical Report K)
- Transport model elements (base year and future year/forecast scenarios)

M.1.3 Outline of Inter-Relationships

Figure M.1 shows typical inter-relationships between the GIS database, traffic surveys, transport modelling and other study tasks. It is intended that the transport/traffic database will cover all of these areas.

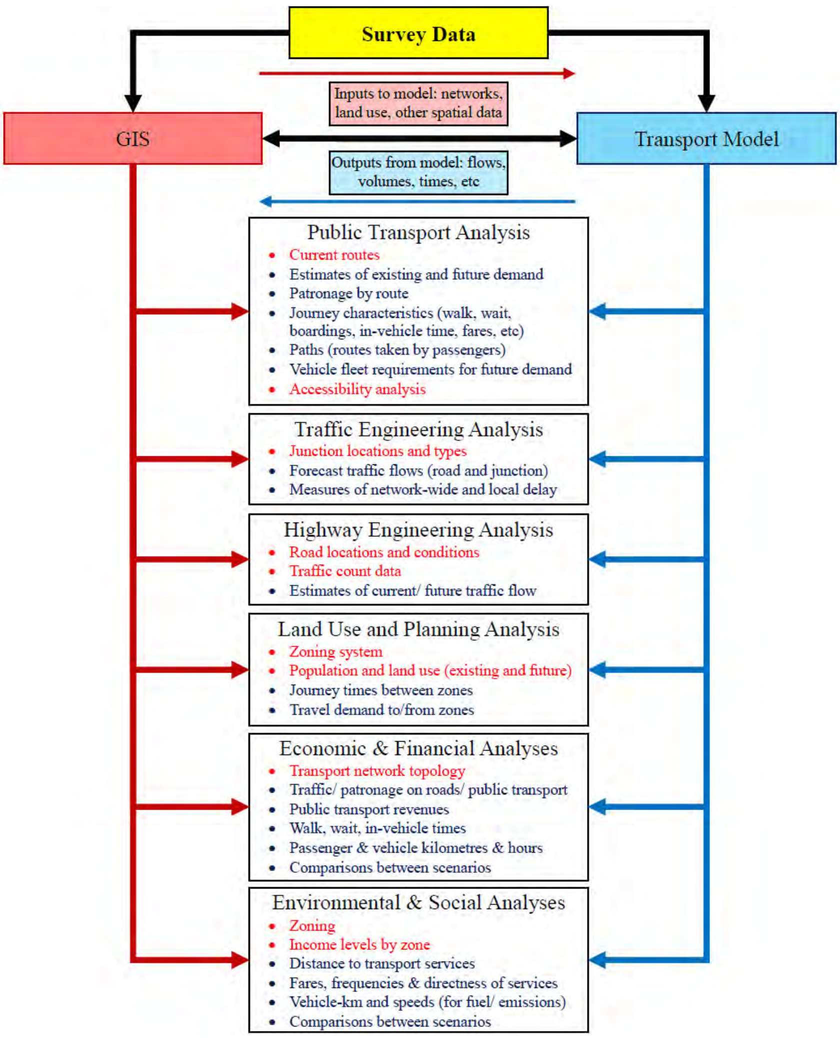


Figure M.1: GIS, Transport Modelling and Other Study Tasks

M.2 Transport Survey Data

M.2.1 Introduction

This chapter sets out the survey data which will be included in the transport survey database. More information on the transport surveys is presented in Technical Report K.

M.2.2 Inventory Surveys

Much of the inventory survey data are already coded into ArcGIS. These comprise:

- ArcGIS Line Data; and,
- ArcGIS Point Data.

The structure of these data is presented in Figure M.2.

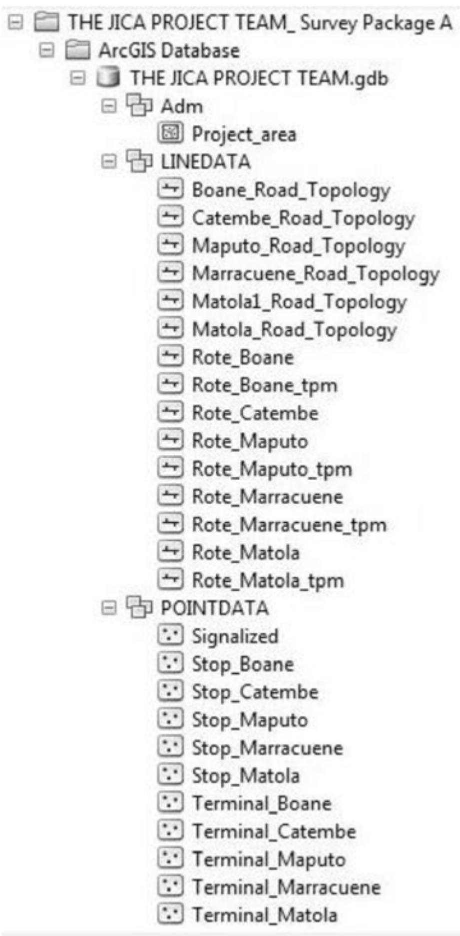


Figure M.2: Structure of Inventory Survey Data in ArcGIS

The ArcGIS Line Data contains the following information for the whole study area, per sub-area, i.e. Maputo (incl. Catembe), Matola, Marracuene and Boane:

- A layer of the updated public transport routes; and
- A layer of road topology

Table M.1 gives the data structure of ArcGIS Line Data.

Table M.1: Data Structure of ArcGIS Line Data

Data Description	Data Type (for ArcGIS Entry) Coding from ToR	Coding by Aurecon
Start Node	reference to point datum (Node number)	Start_Node
End Node	reference to point datum (Node number)	End_Node
One Way/ Two Way	Flag	Way
Exists in Current Year?	True/False	Exist_Year
Link Identifier 1st Direction	e.g. StartNode &"_"& EndNode	LinkID_1st_D
Link Identifier 2nd Direction	e.g. EndNode &"_"& StartNode	LinkID_2st_D
Road Name	string/ label	Road_Name
Section (Link) Length	in km	Secc_Length
Management Entity	string/ label	Manag_entity
Road Definition	e.g. Primary/ Secondary/ Tertiary/ Urban	Road_Def
Paved/ Unpaved	Flag	Paved_unpaved
Lanes in 1st Direction	number	Lanes_1stD
Lanes in 2nd Direction	number	Lanes_2ndD
Speed Limit 1st Direction	kph	SpeedLimit_1stD
Speed Limit 2nd Direction	kph	SpeedLimit_2stD
Central Median?	True/ False	Central_median
Median used for Parking?	True/ False	Median_parking
On-Street Parking 1st Direction	True/ False	Street_parking_1st
On-Street Parking 2nd Direction	True/ False	Street_parking_2nd
Tolls 1st Direction	Index	Tolls_1stD
Tolls 2nd Direction	Index	Tolls_2ndD

The ArcGIS Point Data contains a layer of stops, stands, and terminals.

M.2.3 Household Interview Surveys

The Household Interview Survey (HIS) data are contained in an Excel spreadsheet file, with the following data fields:

- B-zone, C-zone, Sequential zone and HIS survey zone number of household
- X- and Y-coordinate of household
- Numbers of bicycles, motorcycles, cars, minibus, bus, 2–3 axle trucks and larger trucks owned by household
- Household income per month
- Number of household members; those aged six years and above present and absent; those aged under six present or absent
- Household member index number
- Sex and age
- Occupation and industry
- Whether a driving licence is held
- Location of school or workplace (if appropriate)
- Number of trips made; and if appropriate for each trip:
  - Origin zone (C and sequential)
  - Land use at origin
  - Departure time
  - Arrival time
  - Destination zone
  - Destination land use and purpose
  - Number of legs on trip, and for each leg:
    - Mode

    - In-vehicle time
    - Waiting time
    - Interchange location
  - Public transport fare paid
  - Road toll paid
  - Number accompanying
  - Parking charges paid
  - And for some of these:
    - Why this mode was chosen
    - Estimates of journey time by alternative public transport route
    - Estimate of car journey time
    - Walking time by alternative public transport route
    - Waiting time on alternative public transport route
    - Fare by alternative public transport route
    - Number of interchanges required on alternative public transport route
    - Car toll, fuel consumption and parking charge if car had been chosen

M.2.4 Traffic Count Data

(1) Format

Traffic count data are in Excel format.

(2) Data Sources

Traffic counts were conducted as part of the following surveys:

- Cordon surveys
- Screenline surveys
- Freight surveys
- Junction surveys

Whilst most of the junction survey sites comprised turning movement volumes, all other data comprised link counts. Occupancy surveys were also conducted as part of many of these surveys. Where Roadside Interviews (RSI's) were conducted (see M.2.5) occupancies were also collected.

Occupancy surveys were expanded to traffic count totals. Similarly, traffic counts were expanded to 24-hour counts.

(3) Traffic Count Data on Vehicle Movements

These comprise:

- Location
- Direction
- Hour
- Flow
- Vehicle type: bicycle, motorcycle, car, chapa, minibus, bus, 2–3 axle truck, larger truck, and sometimes taxi (other times taxi are combined with cars). For freight surveys, goods vehicles are in four categories: pick-up, 2–3 axle truck, >3 axle and container.

(4) Traffic Count Data on Person Movements

These comprise:

- Location
- Direction
- Hour
- Flow
- Vehicle type: bicycle, motorcycle, car, chapa, minibus, bus and sometimes taxi (other times taxi are combined with cars). No passenger occupancy data were collected for goods vehicles

M.2.5 Roadside Interview Survey Data

(1) Format

Roadside Interview (RSI) data are in Excel format.

(2) Data Sources

RSI's were conducted as part of the following surveys:

- Cordon surveys: for data on passenger vehicles and some freight vehicles
- Freight surveys: for additional data on goods vehicles (trucks)

(3) Data on Private Passenger Vehicles (Car, Motorcycle)

Data collected comprise:

- Time of interview
- Type of vehicle
- Origin
- Destination
- Trip purpose
- Number of passengers

(4) Data on Public Passenger Vehicles (Chapa, Bus)

Data collected comprise:

- Time of interview
- Type of vehicle
- Origin
- Destination
- Trip purpose
- Number of passengers
- Trip cost (fare)

(5) Data on Goods Vehicles

Data collected (both from cordon surveys and from freight surveys) comprise:

- Time of interview
- Type of vehicle
- Origin
- Destination

- Type of load
- Loading factor
- Vehicle capacity

M.2.6 Public Transport Surveys

(1) Format

Public Transport Survey data are in Excel format.

(2) Data Sources

Public transport surveys were conducted at four chapa terminals (Museu, Zimpeto, Xipamanine and Liberdade). These pertained to individual vehicles, identified by their registration numbers.

(3) Data

The survey database comprises the following data:

- Location
- Terminal
- Surveyor information and identity of data processor
- Date of survey
- Vehicle entering or exiting terminal
- Time vehicle observed
- Vehicle type (size)
- Registration number
- Capacity
- Classification: formal chapa, TPM bus, informal
- Origin of trip (for arriving vehicles) or destination of trip (for departing vehicles)
- Loading factor

Technical Report N

Demand Forecasting: Methodology and Analysis

Contents

Figures

Tables

Technical Report N Demand Forecasting: Methodology and Analysis

N.1 Household Interview Survey

N.1.1 Survey Outline

The Household Interview Survey (HIS) was conducted to understand the travel patterns of the residents within Greater Maputo. An examination of the travel patterns determines the origin and destination of trips, the reasons for travel, as well as the time and modes of transportation used for travel.

After checking for errors, the collected HIS data was aggregated and analyzed to comprehend the current traffic situation of Greater Maputo. Then, traffic demand was forecasted to consider the comprehensive urban transport system for Greater Maputo, including a public transport and road network development plan, terminal improvement plan, and district traffic plan.

(1) Survey Items

The information collected through the HIS can be categorized into (1) household, (2) individual, and (3) trip information.

Table N.1: Survey Items

Categories	Survey Items
Household information	Address Number of families Number of vehicles
Individual information	Sex, Age Occupation Location of work or study Monthly income
Trip information	Origin, Destination Departure and arrival time Trip purpose Transport mode Travel time, waiting time Travel cost Parking place

Source: JICA Project Team

(2) Zoning

There were two zoning system for the survey area; the B-Zone with a size that would be adequate to examine the arterial traffic network, and the C-Zone which divided the urban center into smaller sections to assess the detailed forecast and planning.

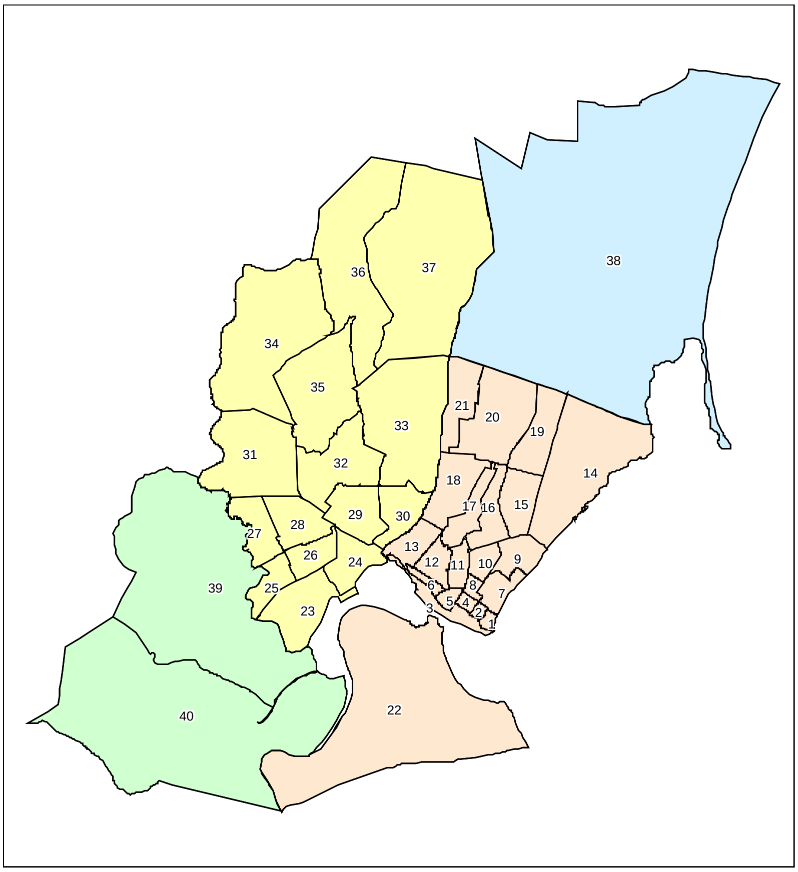
The size of the B-Zone was set using the “Bairo”, the smallest unit used for the population census data. A part of the suburbs were zoned in a way that consolidated a few bairos. The number of zones within the survey area was 40.

For the C-Zone, bairos were broken down into smaller sections to accommodate the road network in the city center, whereas bairos were used as the smallest unit in the suburb. The number of zones within the survey area was 170.

Table N.2: Zoning

Area	A-Zone	B-Zone	C-Zone
Maputo	1	1–22	1–111
Matola	2	22–37	112–157
Part of Marracuene	3	38	158–161
Part of Boane	4	39–40	162–170

Source: JICA Project Team



Source: JICA Project Team

Figure N.1: Zoning (B-Zone)

(3) Sample Size

The following basic premises were set to examine the sample size required for this survey.

- Population of the study area[1]: 2,211,257
- Population 6 years and older: 1,850,456
- Number of daily trip per person: 1.5
- Number of travel purposes: 5 (trips to work, trips to school, trips for business, trips for private purpose, and trips to home)
- Number of travel mode: 3 (walk, private vehicle, and public transport in B-Zone)
- Confidence level 95% (k=1.96)

[1] INE population forecast (2012) by bairo

To maintain the relative error lower than 20%, the sample ratio r was calculated as follows:

$$0.2 \geqq 1.96 \sqrt{(40 \times 5 \times 3 - 1) \times \frac{1-r}{r} \times \frac{1}{1{,}850{,}456 \times 1.5}}$$

This yields that the sample rate r $\geqq$2.03%, meaning that the required sample size is 56,300 trips. With the average household size of 4.79 persons (2007 population census), the required number of sample households is 9,374; thus, the sample size was set at 10,000 households.

(4) Sampling Methodology

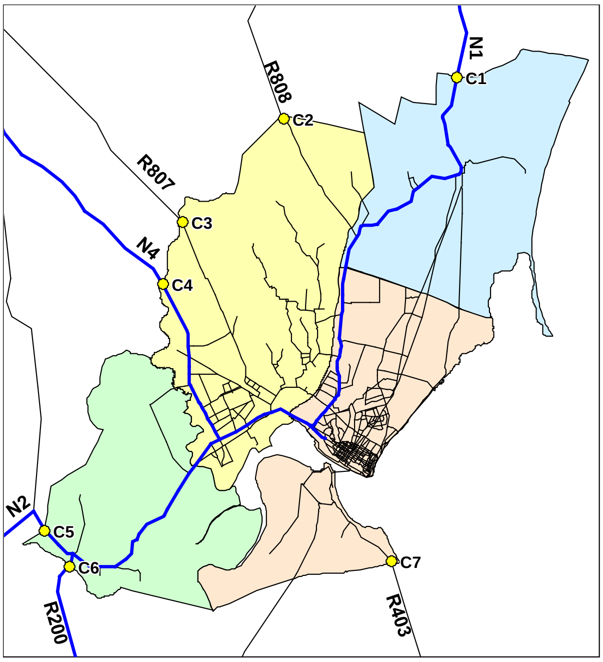
The basic residential registration that exists for the study area is only that of 2007. Because the registration does not cover new residences and squatter areas, data acquisition takes time, and the suburbs do not have detailed addresses, the project team used a recent satellite map to establish the required number of dwellings for each district. Following the extracted set of rule, the surveyors visited households in each district.

(5) Other Surveys

<u>Cordon Line Survey</u>

Although the HIS provides information on the travel patterns of the residents in the survey area, it does not provide traffic inflow originating outside of the survey area. The cordon line survey instead provides information on the inflow of traffic.

Survey points C1 to C7 were positioned where the border of the survey area intersects with roads N1, R808, R807, N4, N2, R200, and R403. An OD survey was conducted for the traffic crossing the border of the survey area, and traffic volume was also monitored.



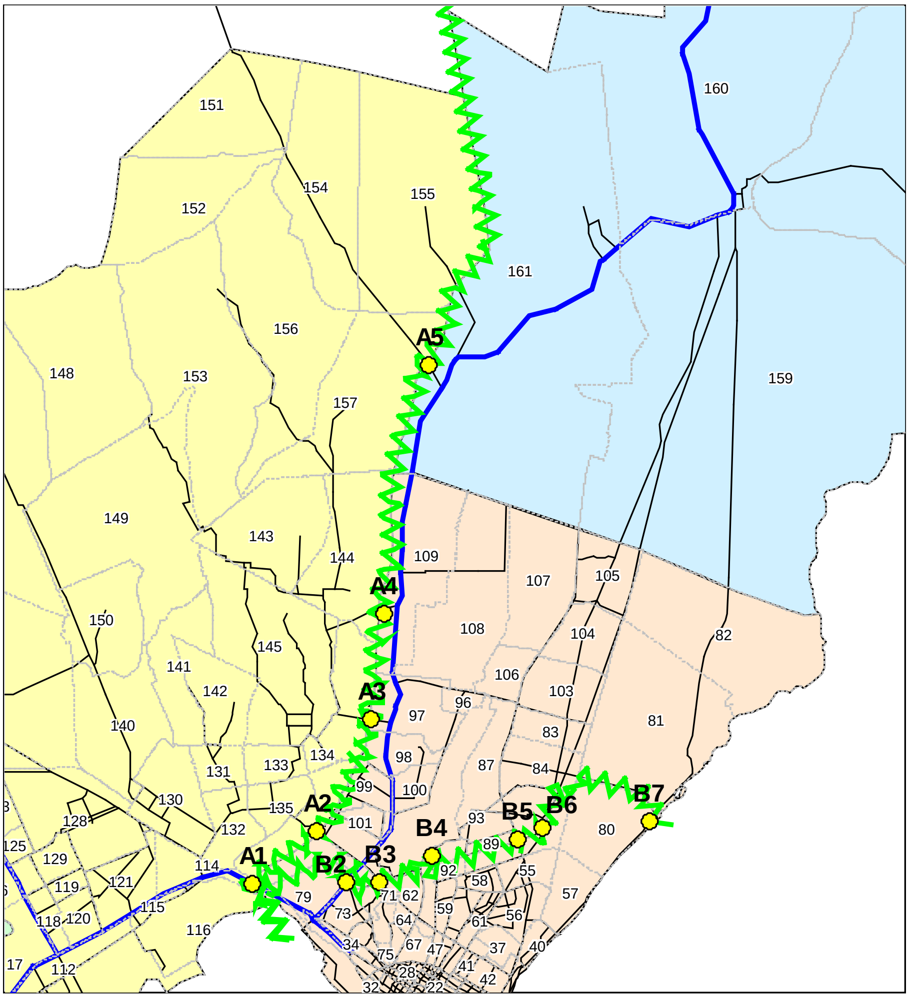
Source: JICA Project Team

Figure N.2: Cordon Line Survey Points

Screen Line Survey

The screen line survey divides the survey area into two zones with several crossing points between them. The screen line survey was conducted to correct the amount of traffic crossing the lines derived from the HIS so that it will be the same as the traffic amount observed.

This survey drew two screen lines. The first separated Maputo and Marracuene from Matola and Boane using survey points A1 to A5. The second separated the urban centre of the City of Maputo from the rest, and survey points for this line were A1, and B1 to B7.



Source: JICA Project Team

Figure N.3: Screen Line Survey Points

Traffic Survey at Freight Facilities

To supplement the freight traffic that was not captured in the HIS, traffic volume count and OD interviews were conducted at the entrances and exits of the port and airport, and a cargo OD matrix was prepared.

N.1.2 Data Processing

With the collected HIS questionnaires, the address, and origin and destination were coded according to the zone number and this data was input into a computer. The data was processed as follows.

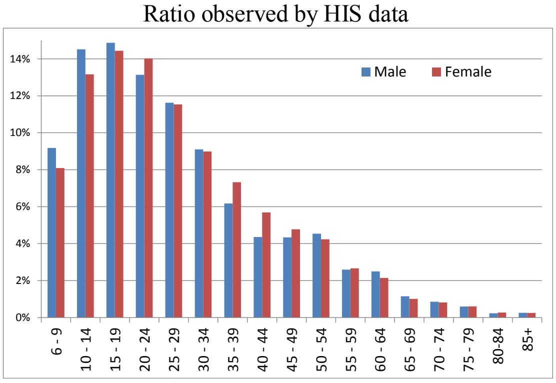
Error Check and Correction of HIS Data

Data range and its logic were examined based on the questions, and when errors were found, the original data in the survey questionnaires were examined and re-input to a computer.

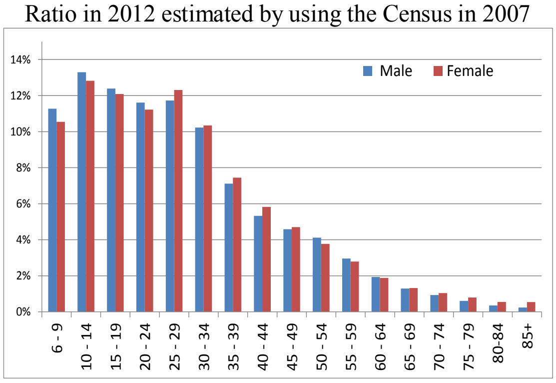
Examine Methods of Expanding the Data, and Conduct Expansion Tasks

After compiling the HIS data with errors corrected, the sample ratio by sex and age group was compared between the HIS data and the 2012 ratio that was estimated based on 2007 population census. The sample ratios showed similar trends (Figure N.4). Only the sample of 6–9 years of age demonstrated that the HIS ratio was slightly lower than that of the 2012.

Ratio observed by HIS data



Ratio in 2012 estimated by using the Census in 2007



Source: JICA Project Team

Figure N.4: Ratio of Samples by Sex and Age Group

Chi-square test for the above data provided that the chi-square value by sex was much smaller than the limit value of 26.3 when the degree of freedom is 16 and the significance level is 5%. Therefore, it was confirmed that the HIS data sample by age group has no statistically significant difference from the population census sample by age group.

Male: $\chi^2 = 0.0196 < 26.296$
Female: $\chi^2 = 0.0254 < 26.296$

From this, the HIS data was expanded using the expansion rate derived from the night-population of 6 years and older by B-Zone as well as from the sample number, instead of using the expansion rate derived from the population by sex and age group.

OD Matrix of the Cordon Line

The OD matrix for the cordon line was prepared using the OD sample collected from the cordon line survey and traffic count, calculating the expansion rate by vehicle type and time of day. As the traffic that enters and exits the survey area was counted at two cordon points, the double-counting was eliminated.

OD Matrix for Freight Facilities

The OD matrix was created based on the traffic count and the OD interview survey conducted at the entry and exit points of cargo facilities.

HIS Screen Line Correction

From the expanded HIS data, the OD table was prepared, then the traffic that passes the screen line was calculated ($T_{HIS\text{-}OD}$). Likewise, the traffic that crosses the screen line was calculated for the cordon line OD and freight OD ($T_{Cordon\text{-}OD}$) ($T_{Truck\text{-}OD}$).

The correction rate (α) was calculated for each vehicle type for the actual traffic volume counted on the screen line, and the OD table for HIS was corrected.

$$\alpha T_{HIS\text{-}OD} + T_{Cordon\text{-}OD} + T_{Truck\text{-}OD} = T_{Screen\text{-}Vol}$$

As two screen lines were set for this study, a correction rate that satisfies the above formula for both was calculated.

N.1.3 Summary of HIS Results

(1) Summary of Sample Size

The sample size before expanding HIS data is summarized below. With the target number of households of 10,000, the study was able to collect valid replies from 9,983 households.

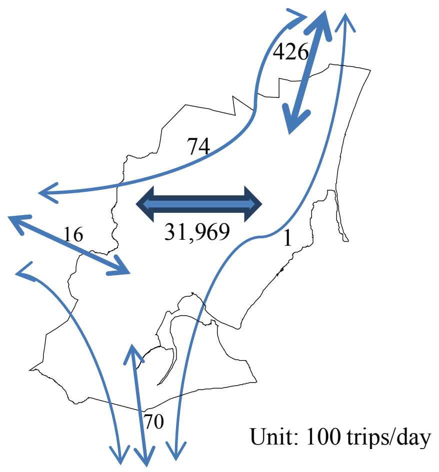
Table N.3: Outline of the Effective Samples

Responded households	10,037	
Effectively responded households	9,983	
Total number of family members	38,216	
Total number of daily trips	52,656	
Number of households owning cars	1,297	(13% of responded HH)

Source: JICA Project Team

(2) Total Number of Trips

The 2012 HIS revealed that the total of 3,270,000 trips were made in one day within the study area. Of these, 3,200,000 trips originated and destined within the study area, accounting for approximately 98% of the entire trips. This can be interpreted that the study area itself is rather closed off in terms of traffic.



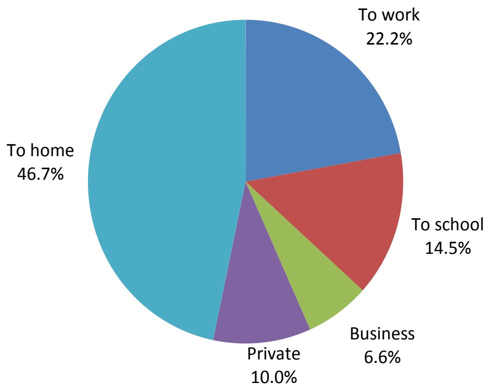
Source: JICA Project Team

Figure N.5: Number of Trips

(3) Breakdown of Trips

Purpose of Trip

The breakdown of the trip purposes within the study area are to go home (47%), to go to work (22%), to go to school (15%), for private errand (10%), and for business (7%). As return-to-home trips account for almost half of the total number of trips, it can be said that most trips are straightforward in that they are made to go somewhere for a purpose before returning home.

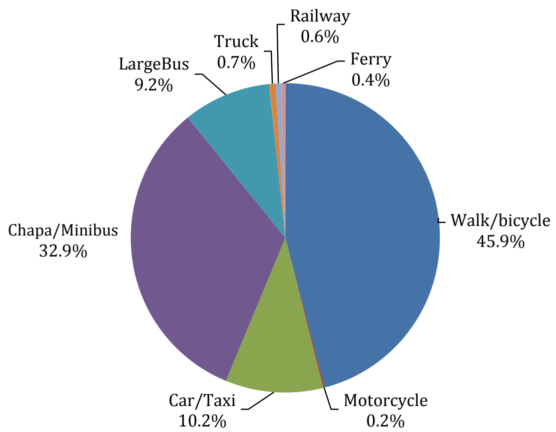


Source: JICA Project Team

Figure N.6: Breakdown of Trip Purpose

Main Modes of Transport

The main modes of transport for the trips in the study area are walk/bicycle (46%), chapa/minibus (33%), car/taxi (10%), large bus (9%). Chapa/minibus and large buses together are 42% of trips, demonstrating the importance of public transport as a means of transportation.

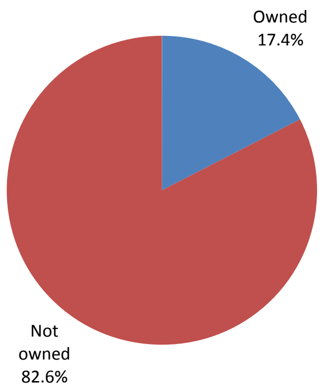


Source: JICA Project Team

Figure N.7: Breakdown of Transit Modes

Private Car Ownership

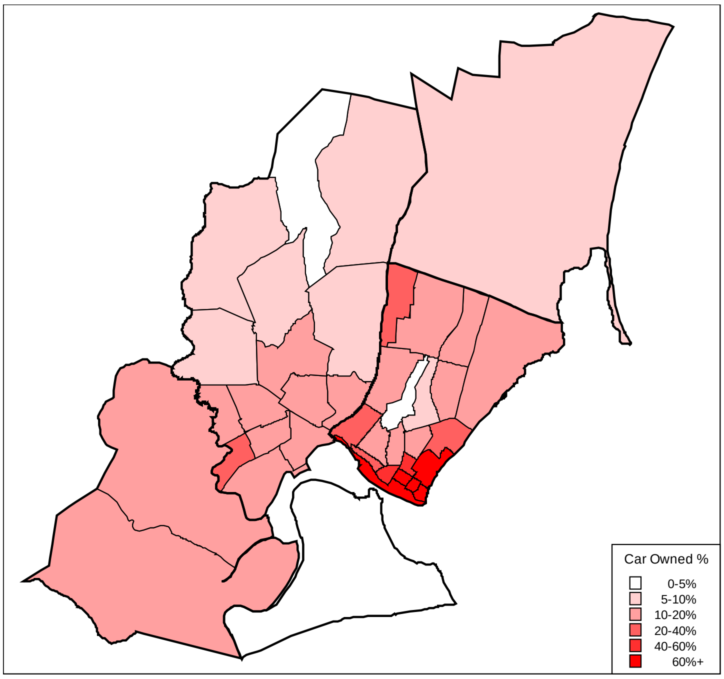
The number of sampled trips originating from households with at least one private car accounted for 17% of total trips within the study area. On the other hand, the numbers of trips from households with no car occupied 83%.



Source: JICA Project Team

Figure N.8: Trip Ratio by Car Ownership

The largest number of trips from households with at least one private car is in Maputo City followed by Matola. There are zones in the center of Maputo with over 60% of households that own cars.



Source: JICA Project Team

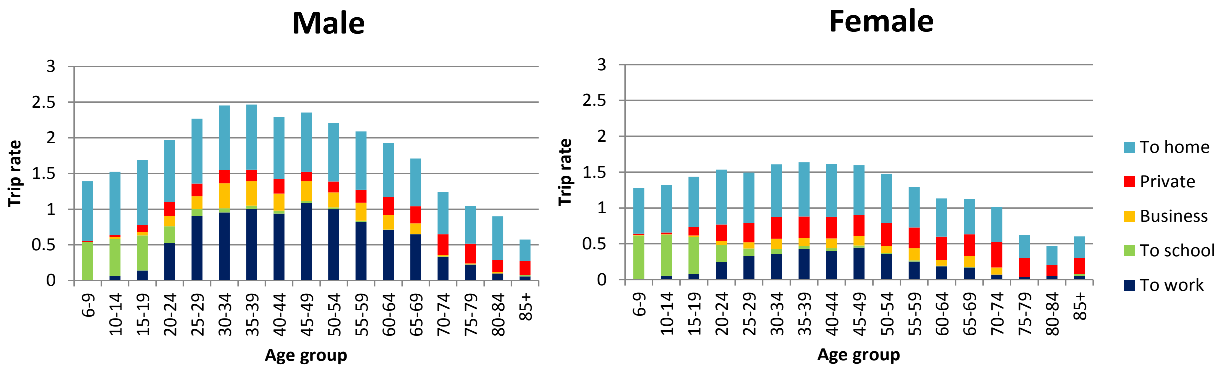
Figure N.9: Trips by Car Ownership for B-Zone

(4) Trip Production

Trips by Sex, Age Group, and Purpose

In terms of the trips by sex, males make 1.9 trips, higher than females 1.5 trips. Examining by age groups, the trips generated by males increase according to age, peaking at the late-30s (2.5 trips), then decreases. For females, the trip rate is relatively consistent from the late-teens with the peak at the late-30s (1.6 trips), then gradually decreases.

As for the trip purpose, many trips for both males and females are related to school until they are in their late-teens, then from their 20s more trips are related to business. Fewer trips to school are made by females than males and more for private errands such as shopping.

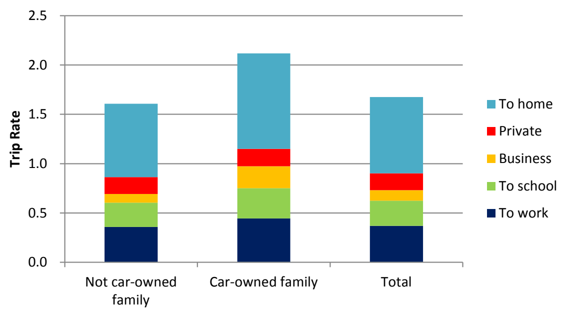


Source: JICA Project Team

Figure N.10: Trip Production Rate by Sex, Age and Purpose

Car Ownership and Purpose

Figure N.11 presents that those in a household with a car make 2.1 trips and those in a household with no car make 1.6 trips, signifying that those with car have higher trip rate by 0.5. Regarding trip purposes, households with cars make more trips for school and business.



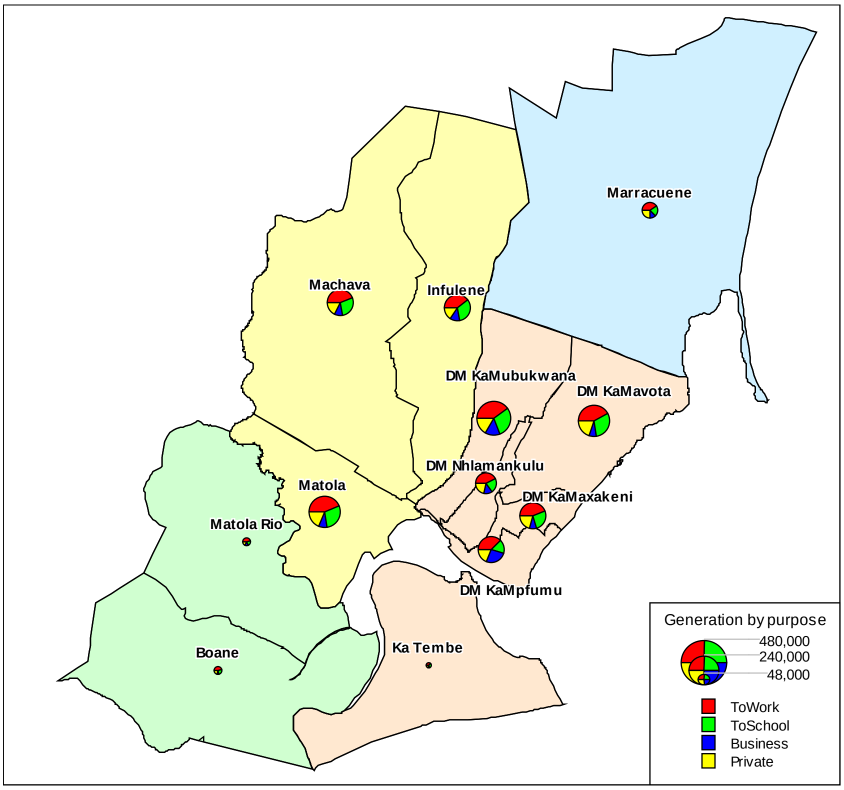
Source: JICA Project Team

Figure N.11: Trip Production Rate
by Car Owning and Purpose

(5) Trip Generation and Attraction

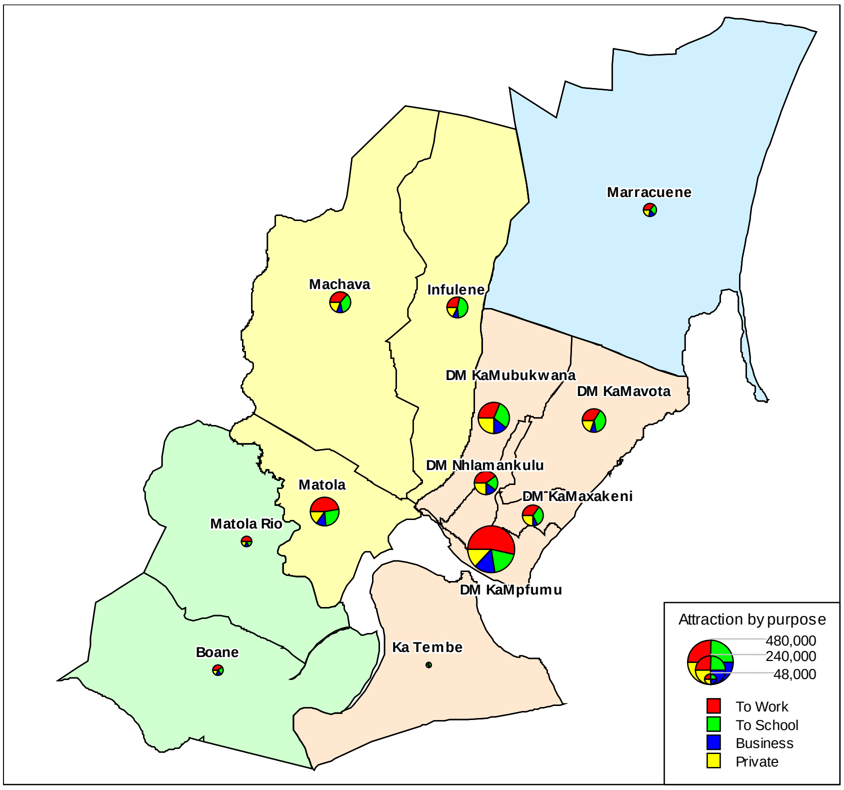
Trip by Purpose

Figure N.12 illustrates trip generation and attraction distribution by purpose in the collected B-zones except return-to-home trips. The largest trip generation zones are DM KaMubukwana in north-west of Maputo, DM KaMavota in north-east of Maputo, and the center of Matola. Trip generated from these areas are mainly composed of work and school purposes, accounting for approximately 70% of the entire trips. On the other hand, the trip generated from DM KaMpfumu in the center of Maputo is predominantly for business purpose. Trip attracted to DM KaMpfumu dominates followed by DM KaMubukwana and the center of Matola. Trip to DM KaMpfumu and Matola is to work, occupying 50% of the entire trips.



Source: JICA Project Team

Figure N.12: Trip Generation by Purpose

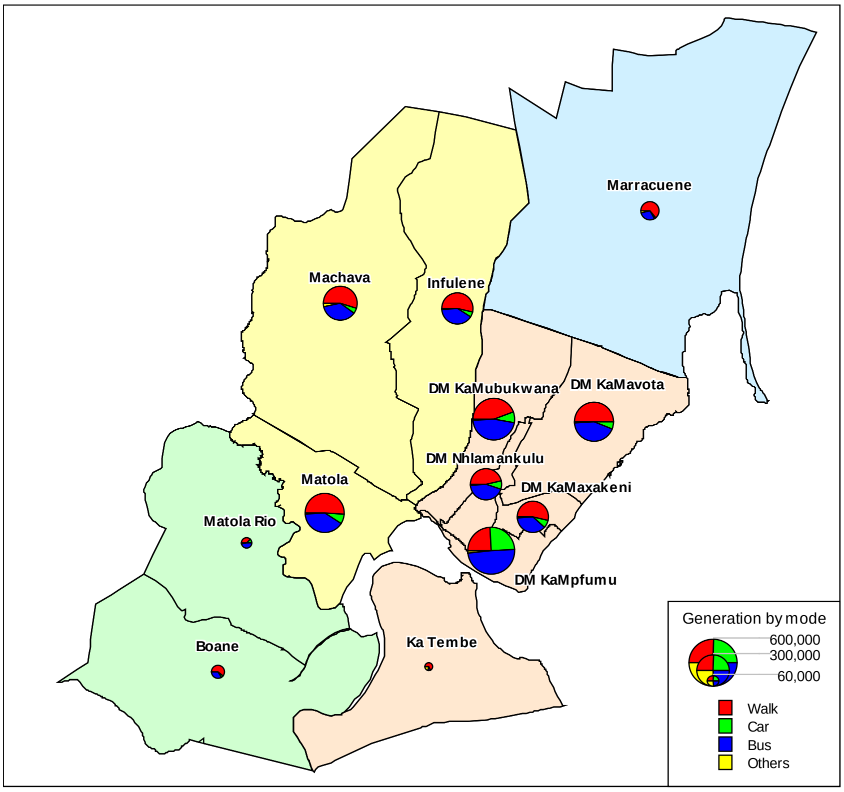


Source: JICA Project Team

Figure N.13: Trip Attraction by Purpose

Trip by Mode

Regarding the trip characteristics between generation and attraction of each zone by mode, no big difference was found because travelers generally use the same travel modes for return trips. Figure N.14 shows trip distribution generated from the collected B-zone by mode. DM KaMpfumu generated the highest car and bus trips, accounting for 25% and 49% respectively. While other zones generated higher walking and bus trips, they generated fewer car trips.

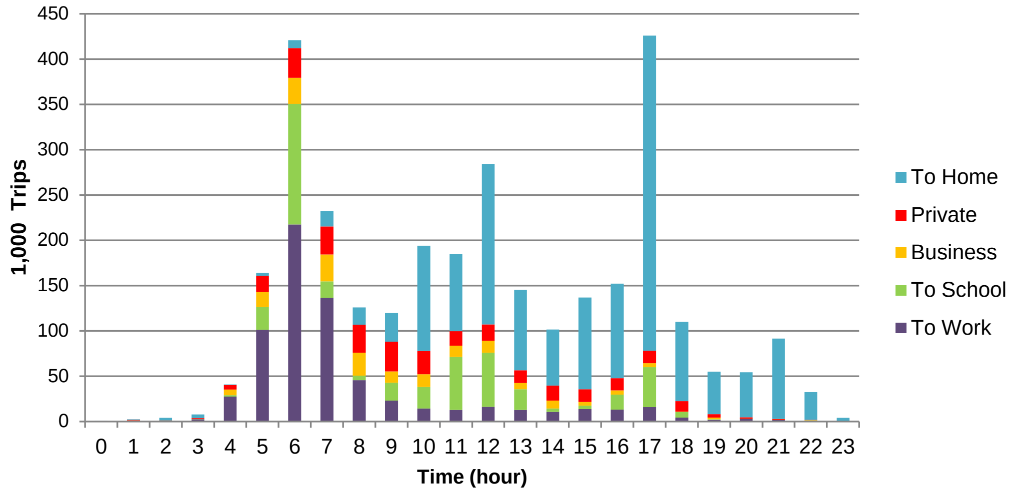


Source: JICA Project Team

Figure N.14: Trip Generation by Mode

Trip Generation by Time

Figure N.15 indicates the number of trips by departure time and purpose. The morning peak is around 6:00 and the evening peak is around 17:00. There is a day time peak at around 12:00 in between. Majority of the trips during the morning peak period is for commuting to work and going to school, whereas the evening peak is mostly for returning home. During the day time peak, though it is not so evident, 60% of the trips are for returning home and 20% for going to school, implying that some group of students go to school after work.



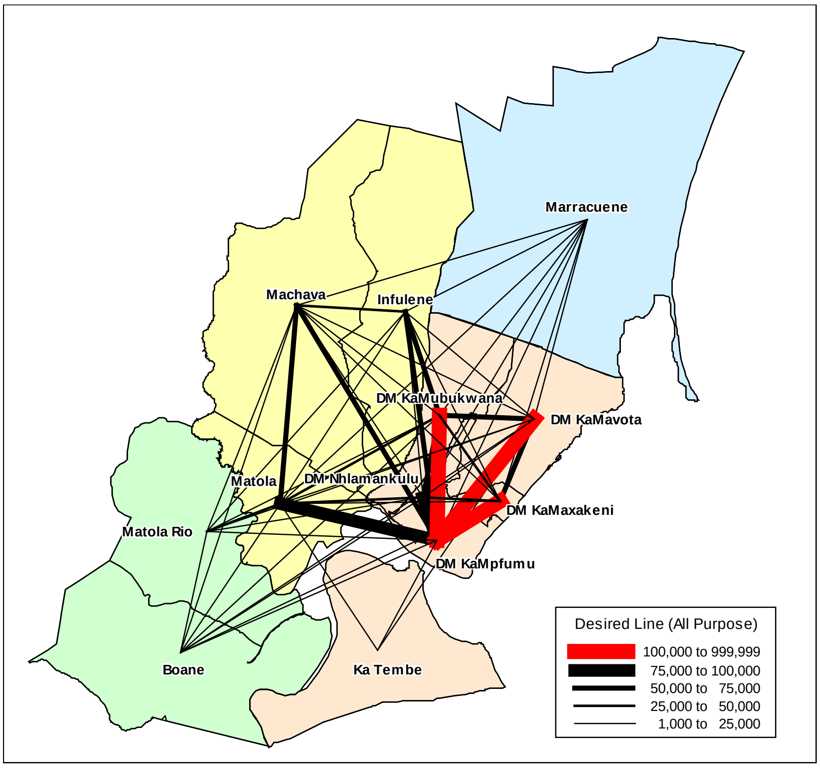
Source: JICA Project Team

Figure N.15: Number of Trips by Departure Time and Purpose

(6) Total Trip Distribution

<u>All Purposes</u>

Strong ties are seen between DM KaMpfum and DM KaMubukwana, DM KaMavota and DM KaMaxkeni. Total trips in each of these three links reach over 100,000 according to the desire line of each zone. The same can be said that trips between DM KaMpfum and Matola count 75,000.



Source: JICA Project Team

Figure N.16: Desired Line (All Purpose)

By Purpose

Figure N.17 to Figure N.19 present desire line by trip purpose.

i) Work Purpose

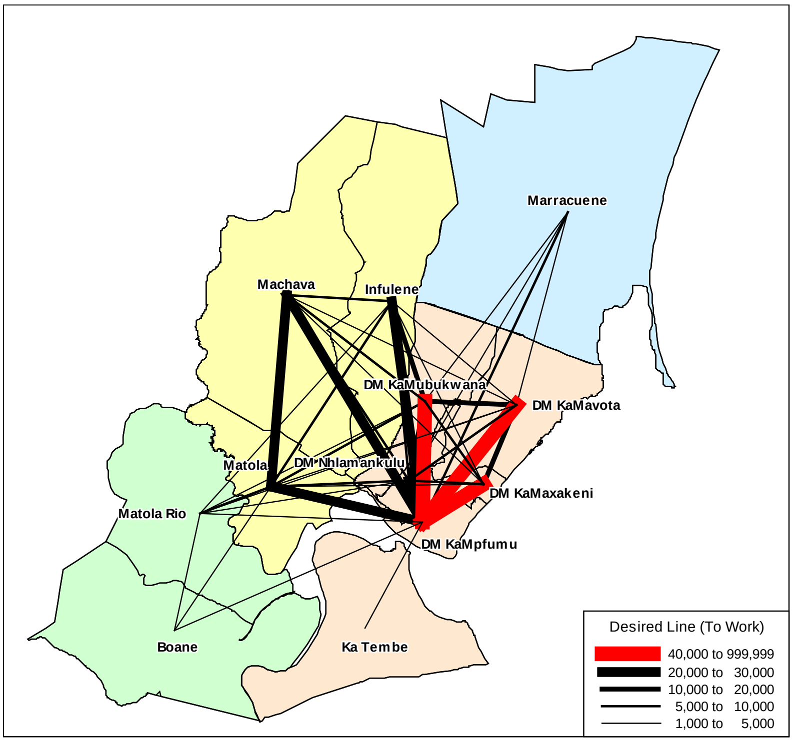
According to the desire line, DM KaMpfumu attracts the largest work trips mainly from north regions in Maputo, Matola and even Maracuenne and Boane. Matola, the second best work trip attraction area, has many trips from the north-west of the city, Machava. On the other hand, work trips between neighbouring zones are fewer compared to trips to the centre of Maputo and Matola.

ii) Schooling Purpose

DM KaMpfumu attracts more trips to school than other areas because universities and schools are concentrated in this area. On the other hand, short trips between neighbouring zones are also observed.

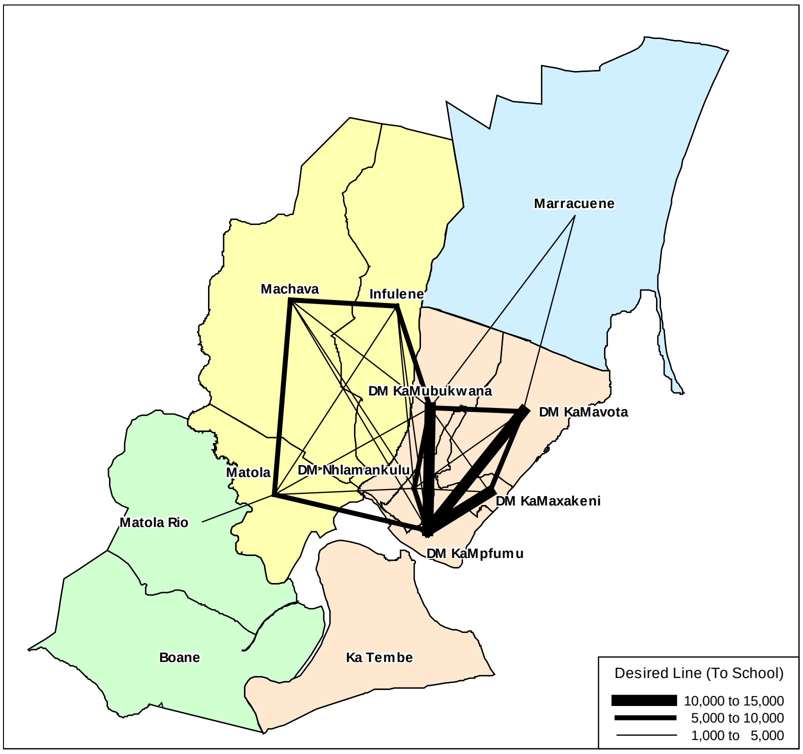
iii) Business and Private Purpose

Trips for business and private purpose are concentrated not only in DM KaMpfumu, but also in the urban Maputo except Catembe. Matola also attracts the trips for this purpose.



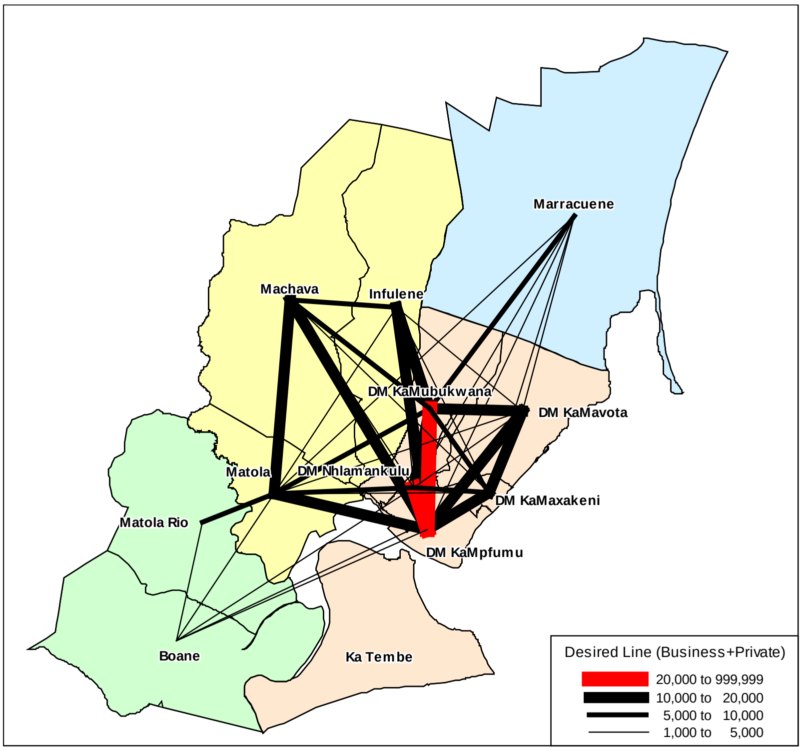
Source: JICA Project Team

Figure N.17: Desired Line (To Work)



Source: JICA Project Team

Figure N.18: Desired Line (To School)



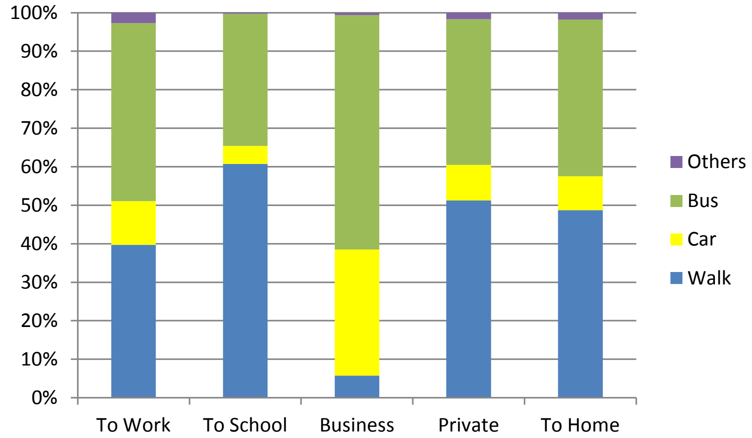
Source: JICA Project Team

Figure N.19: Desired Line (Business + Private)

(7) Modal Share

Modal Share by Trip Purpose

According to Figure N.20, modal share trend shows that bus has the highest share for work trips, followed by walking. On the contrary, walking has the highest share for school trips, followed by bus. Although bus dominates trips for business purpose, significant shares by car are evident, which is different from modal shares of the other purposes. Walking occupies the highest share for private and return-to-home trips, followed by bus.



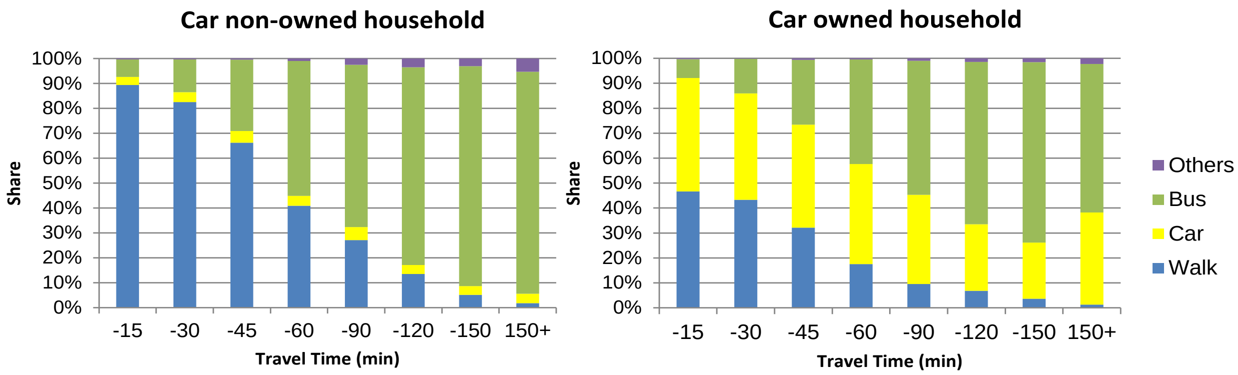
Source: JICA Project Team

Figure N.20: Modal Split Rate by Purpose

Modal Share by Travel Time

Figure N.21 compares the modal share of households with and without car by travel time. For the household with no car, when the travel time is less than 30 minutes, 80% of trips are made by walking, followed by 20% of public transport. The share of walking decreases with an increase in travel time, and instead the use of public transport including bus increases.

On the other hand, for households with no car, the share of car use for even within 15 minutes travels was same as trips by walking of 40%. The bus use remained only less than 10%. The modal share of bus increased and of walking decreased with travel time increase. However, the share of car use remained constant almost throughout the travel time range.

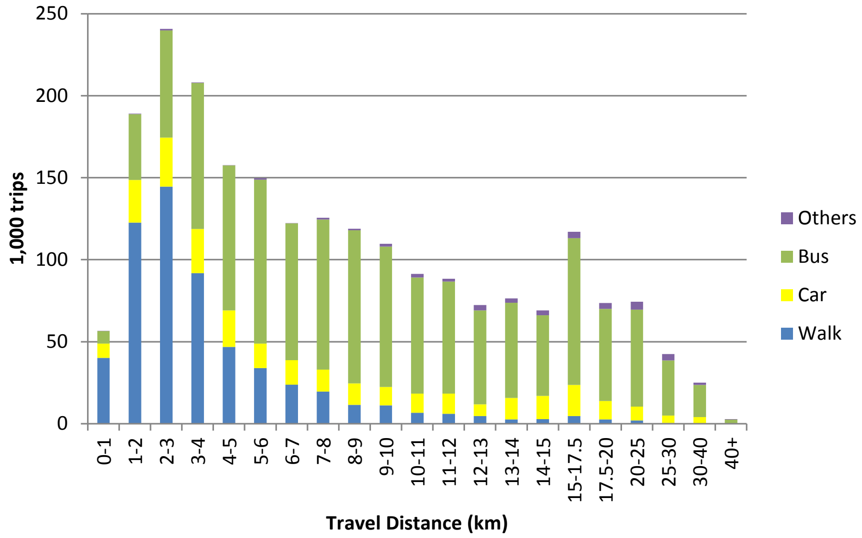


Source: JICA Project Team

Figure N.21: Modal Split Rate by Travel Time

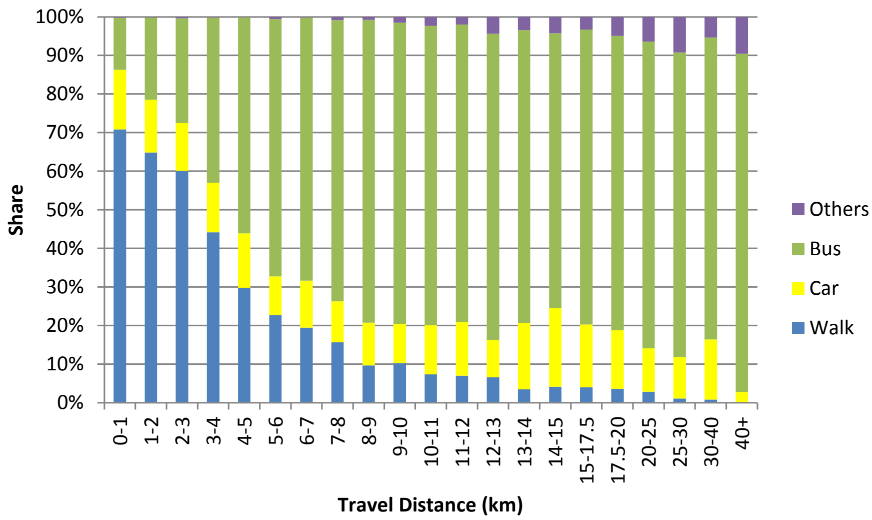
Modal Share by Trip Length

Figure N.22 and Figure N.23 show the number of trips by mode and modal shares by travel distance, which exclude inter-zone trips. The majority of travel distance was 2–3 km and 3–4 km trips follow. The total trips decrease with travel distance because the majority trips of short distance were made by walking. The bus trip share increased to approximately 80% when the share of trips by walking decreased with distance. The number and share of trips by car was constant irrespective of distance travelled.



Note: Intra zone trips are excluded.
Source: JICA Project Team

Figure N.22: Number of Trips by Travel Distance



Note: Intra zone trips are excluded.
Source: JICA Project Team

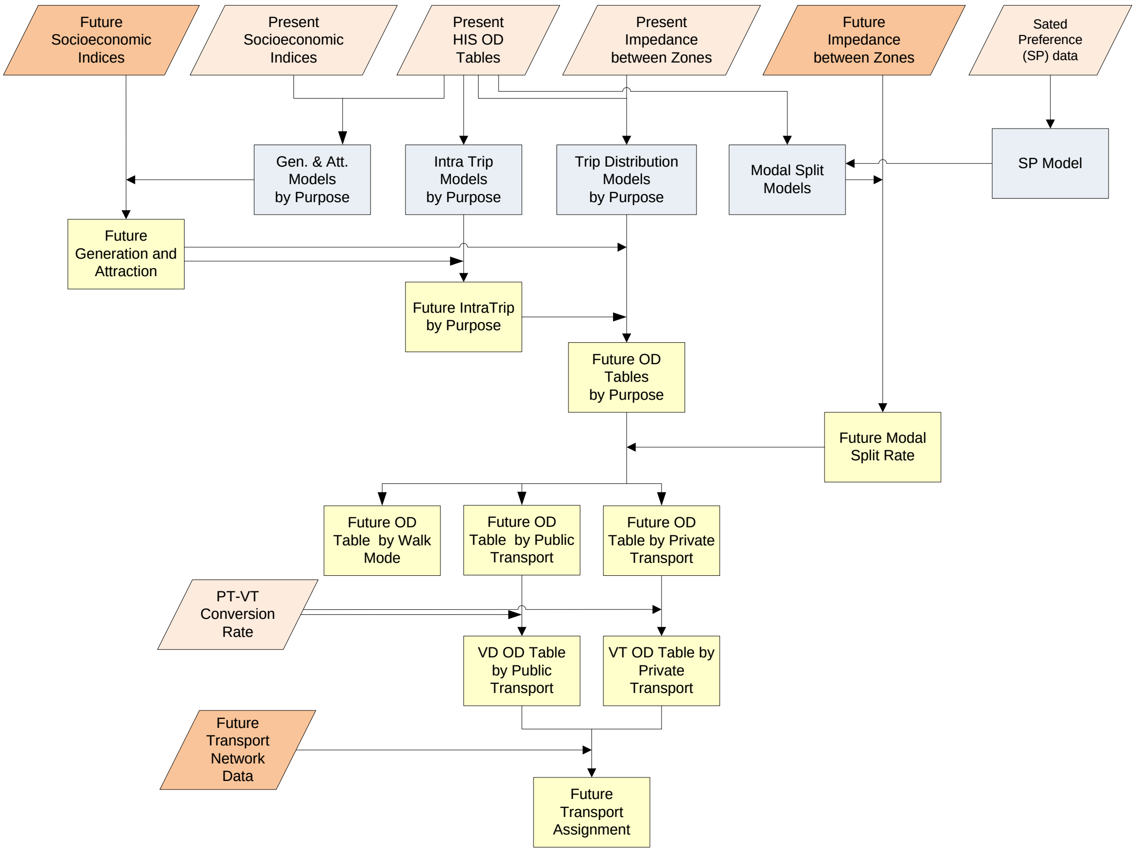
Figure N.23: Modal Split Rate by Travel Distance

N.2 Future Traffic Demand Forecast

N.2.1 Outline of Traffic Demand Forecasting

(1) Procedure

Future traffic demand forecast was conducted using the four-stage transport demand model in which trip generation and attraction, trip distribution, modal share, and traffic assignment are forecasted sequentially. For the first to third stages, future traffic volume is calculated using future socioeconomic indices that are estimated based on a mathematical model. The model uses the current OD matrix derived from the HIS and presents socioeconomic indicators showing the current socioeconomic activities, and presented in a formula.



Source: JICA Project Team

Figure N.24: Traffic Demand Forecast Process

(2) Socioeconomic Condition

The socioeconomic conditions summarized in Table N.4 are applied to the traffic demand forecasting.

Table N.4: Socioeconomic Condition in the Study Area

	2012	2035	2035/2012	Growth Rate
Population (×1,000)	2,169	3,697	1.7	2.2%
GRDP (mil MT)	80,820	325,091	4.0	6.0%
GRDP/Capita (USD)	1,379	3,137	2.3	3.5%
Annual Income (USD)	683	1,554	2.3	3.5%

Source: JICA Project Team

N.2.2 Trip Generation and Attraction

The first step of the four-stage model is to predict the total number of trips generated and attracted to each zone of the study area. The total trip population in the study area was forecasted, and then the trip production and trip attraction for each zone were calculated. Furthermore, adjustments were made to equalize the total trips generated and attracted by zone with the total trip produced in the study area.

(1) Trip Production

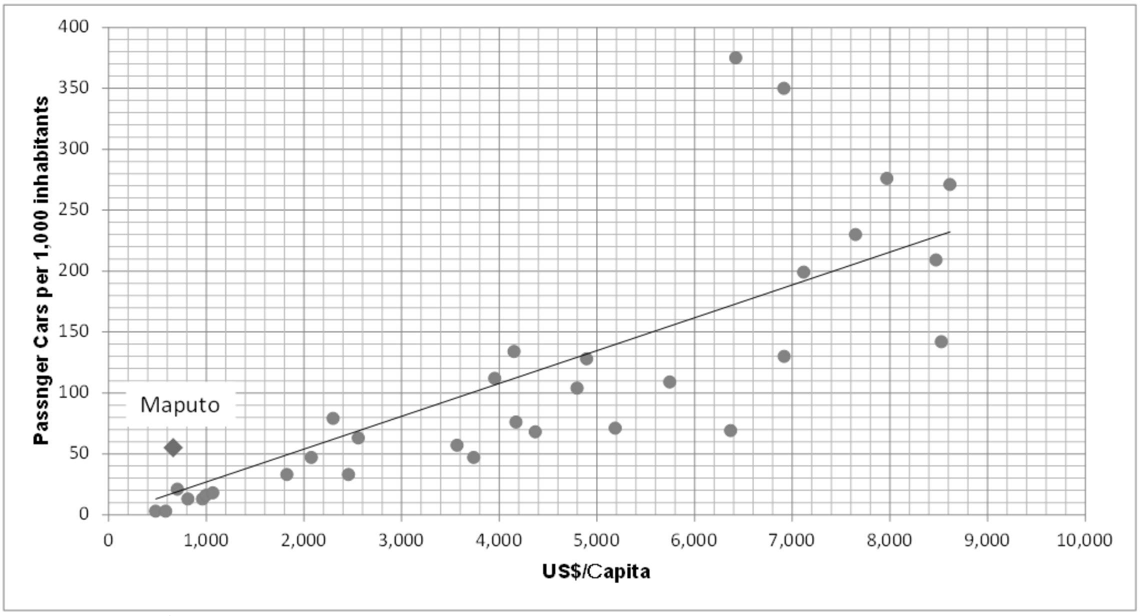
For this survey, future trip production was calculated using the generator method. After analyzing the HIS, there was a clear difference between the trip rate of households with and without car. Therefore, future trip production was calculated based on the future number of households with car, which was calculated from the estimated rate of future car ownership level.

Future Car Ownership

In general, the increase of car ownership can be explained by the growth of income. Figure N.25 shows the relationship between passenger car ownership rate and GDP per capita, which is used as the substitute variable for income, in the countries up to USD 10,000 of GDP per capita. This relationship is expressed mathematically by the following equation:

$$S = 0.027\ X + 18$$

Where,
S: Share of passenger cars (vehicles/1,000 inhabitants)
X: Annual Income (USD, at 2009 constant price)



Source: JICA Project Team

Figure N.25: Correlation of Car Ownership and GDP per Capita (up to USD 10,000 Countries)

Table N.5: Correlation of Car Ownership and GDP per Capita (up to USD10,000 Countries)

	Nominal GDP /capita (USD) (*1)	**Passenger Cars /1,000 inhabitants** (veh) (*2)
Maputo	663	55
Uganda	482	3
Bangladesh	585	3
Cambodia	703	21
Kenya	812	13
Pakistan	962	13
Senegal	999	16
India	1,068	18
Philippine	1,827	33
Sri Lanka	2,077	47
Indonesia	2,299	79
Egypt	2,456	33
Syria	2,557	63
Ecuador	3,570	57
China	3,739	47
Algeria	3,954	112
Thai	4,151	134
Tunisia	4,171	76
Peru	4,370	68
Azerbaijan	4,798	104
Iran	4,896	128
Colombia	5,189	71
South Africa	5,746	109
Botswana	6,370	69
Bulgaria	6,421	375
Malaysia	6,917	350
Mauritius	6,919	130
Kazakhstan	7,119	199
Romania	7,649	230
Mexico	7,970	276
Brazil	8,472	209
Turkey	8,528	142
Russia	8,617	271

Source (*1): IMF World Economic Outlook, (*2): IRF World Road Statistics

Substituting the annual average household income for 2035 into the equation above, the expected rate of car ownership is yielded at 60 cars per 1,000 persons. However, as the car ownership rate in the KaMpfumu was already at 243 cars per 1,000 persons, this ownership rate was kept constant for calculations. The number of vehicles in 2035 was calculated by multiplying the aforementioned car ownership level by the estimated future population (Table N.6).

Table N.6: Number of Vehicles in the Study Area

	Population (×1,000)		**Number of vehicles**	
	2011	**2035**	**2011**	**2035**
KaMpfumu	106	143	26,800	34,900
Other Areas	2,063	3,553	67,500	213,200
Total	2,169	3,697	94,300	248,100

Source: JICA Project Team

Future Population with and without Car

The HIS analysis results presented that 3.85 persons live in KaMpfumu per household and 4.14 persons live in the rest of the study area per household. Assuming that these will remain constant until 2035 and that the households with car have only one car, the population with and without car is summarized in Table N.7.

Table N.7: Number of Population in the Study Area

Unit: 1,000 persons

	Population		Household without Car		Household with Car	
	2011	2035	2011	2035	2011	2035
KaMpfumu	106	143	3	9	103	134
Other Areas	2,063	3,553	1,784	2,670	279	883
Total	2,169	3,697	1,787	2,679	382	1,017

Source: JICA Project Team

Trip Production by Households with and without Car Ownership

Trip production by purpose in 2035 was calculated through the multiplication of the trip production rate of households with and without car gained from the HIS by the respective future population (Table N.8).

Table N.8: Number of Trip Production in 2035 in the Study Area

	Production Rate by HIS		Trip Production in 2035		
	Not car-owning	Car-owning	Not car-owning	Car-owning	Total
To Work	0.356	0.476	955,200	483,700	1,438,900
To School	0.236	0.299	631,800	303,700	935,500
Business	0.090	0.245	241,400	248,800	490,200
Private	0.166	0.181	445,100	184,400	629,500
To Home	0.758	0.956	2,032,000	971,700	3,003,700
Total	1.607	2.156	4,305,500	2,192,200	6,497,700

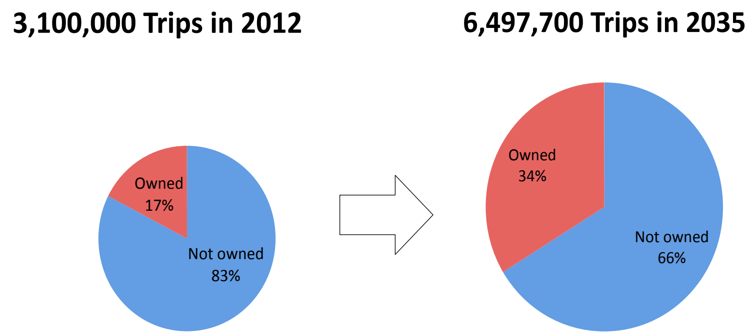
Source: JICA Project Team

In 2035, the number of persons in car owning households will reach 1,020,000, and the number of trips that they will produce will be 2,190,000, approximately four times the current amount of 540,000. On the other hand, the number of persons in non-car owning households will be 2,680,000, and the number of trips produced will be 4,310,000. The total trips for both will be 6,500,000, which is 2.1 times the current amount.

Table N.9: Comparison of Number of Trip Production

	2012	2035	Ratio
Not car-owned	2,559,800 (82.6%)	4,305,500 (66.3%)	1.68
Car owned	540,200 (17.4%)	2,192,200 (33.7%)	4.06
Total	3,100,000	6,497,700	2.10

Source: JICA Project Team



Source: JICA Project Team

Figure N.26: Comparison of Trip Production

(2) Trip Generation/ Attraction

Trip Generation/ Attraction Model

The number of trip generated and attracted were calculated through a regression analysis using the current trip generation and attraction by purpose for B-zone from the HIS, and the socioeconomic indices for each zone. These models were formulated by with and without car ownership as well as by purpose.

$$(\text{Genration}, \text{Attraction}) = a_1X_1 + a_2X_2 + a_3D_1 + a_4D_2$$

Where,
X_1,X_2: *Variable*
D_1,D_2: *Dummy variable*
a_1-a_4: *Parameter*

Model parameters are defined in Table N.10.

Table N.10: Parameters of Trip Generation/Attraction Models

				Workplace Employment		School-place Students	Dummy Variables			Correlation Coefficient
			Population	2nd	3rd		KaMpfumu zone	Underestimated zone	Overestimated zone	
Not Car Owning	To Work	Gen.	0.2588					4,489.53	−9,629.46	0.994
		Att.	0.1286		0.1750		18,338.36	31,789.53	−23,372.33	0.943
	To School	Gen.	0.1733					4,023.46	−2,914.63	0.997
		Att.				0.5021		10,142.64	−9,277.12	0.938
	Business	Gen.	0.0569	0.0683				3,930.97	−3,086.65	0.958
		Att.	0.0329		0.1039			12,026.89	−11,219.04	0.918
	Private	Gen.	0.1187					3,895.65	−5,006.63	0.991
		Att.	0.0894		0.1131			9,621.01	−10,094.89	0.963
	To Home	Gen.		0.8812	0.3391	1.0623	15,719.33	40,476.78	−46,239.88	0.949
		Att.	0.5410					8,303.38	−9,916.19	0.996
Car Owning	To Work	Gen.	0.0400				4,146.72	2,257.98	−3,144.88	0.972
		Att.	0.0220				8,310.95	13,566.31	−4,272.93	0.959
	To School	Gen.	0.0259				1,917.27	1,740.07	−1,193.15	0.972
		Att.				0.0546	3,627.65	2,454.07	−1,907.90	0.944
	Business	Gen.	0.0147				3,839.37	4,654.34	−3,286.95	0.927
		Att.	0.0099		0.0143		2,862.09	3,680.30	−1,618.32	0.936
	Private	Gen.	0.0155				1,713.27	1,080.18	−1,638.31	0.946
		Att.	0.0115		0.0120		1,961.03	1,546.86	−2,415.30	0.925
	To Home	Gen.			0.0434	0.1591	14,628.76	10,377.99	−7,857.03	0.955
		Att.	0.0825				7,762.03	4,604.19	−6,157.79	0.973

Source: JICA Project Team

Trip Generation /Attraction in 2035

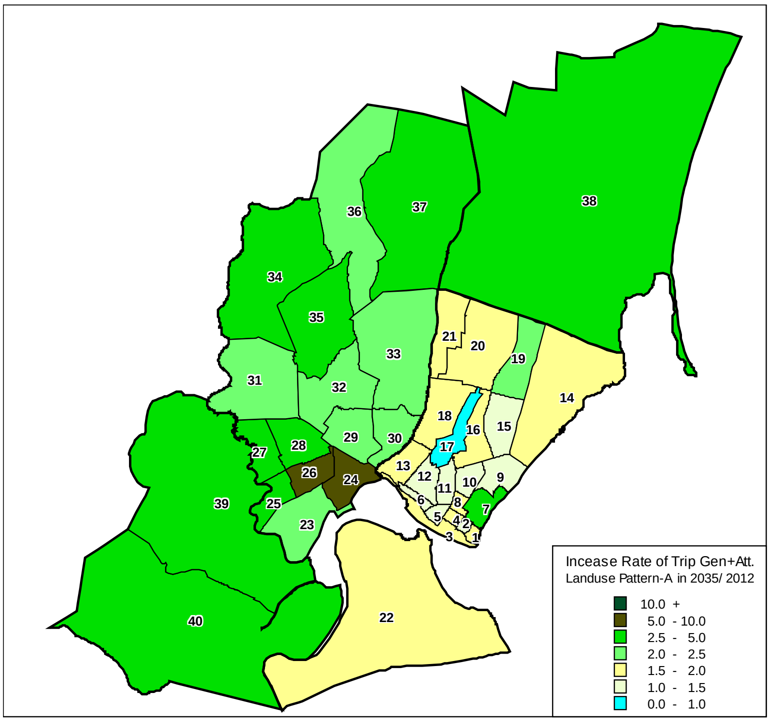
Using the above trip generation / attraction models, the trip generation / attraction for 2035 for each of the three land use patterns was calculated. Then, adjustments were made so that the total trip generation / attraction would equal the total trip production.

Figure N.27 to Figure N.29 and Table N.11 show the increase rate of trip generation and attraction for each of the three land use patterns. Comparing the increase rate among the municipalities, Maputo increases at a rate of 1.6 in all of the land use patterns, whereas the increase rate of Matola varies according to land use patterns and pattern A, B, and C show an increase rate of 2.9, 2.4, and 2.2 respectively. On the other hand, in Marracuene and Boane, patterns B and C have a higher increase rate than pattern A. In Marracuene, the increase rate for patterns A, B and C is 3.3, 4.8, and 5.2 respectively, and the corresponding value in Boane is 3.5, 6.7, and 7.2 respectively.

In the case of land use pattern A (existing trend), the population of Maputo in its city centre becomes 1.0 to 1.5 times, and most of the other areas become around 1.5 to 2.0 times. Meanwhile, in Matola, Zone 24 and Zone 26 along N4 increase by about 6 to 7 times than the current amount, but other areas are 2.0 to 5.0 times. In Marracuene and Boane, the rate of increase will be 2.5 to 5.0.

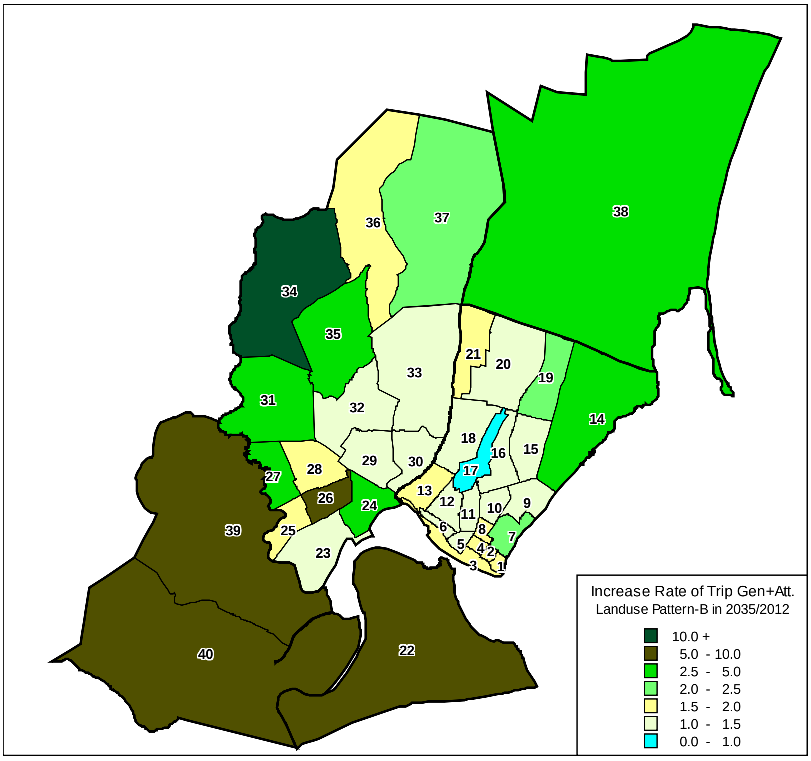
If the land use pattern B unfolds (poly-centric multi-core type), the rate of population increase in Maputo will be 1.6, and it will be especially high for Zone 22 (Ka Tembe) at 5.7 and Zone 14 at 1.9. In Matola, the overall rate of increase will be lower at 2.4, and the increase rate at the city centre will only be 1.0 to 1.5. However, population is expected to increase in the northwest area, especially in Zone 34, at a rate of 11. Marracuene and Boane are expected to have high rates of increase, with Boane being especially high at 6.7.

For land use pattern C (compact corridor), the outcome is similar to pattern B. Marracuene will increase 5.5 times the current amount, and Zone 39 (Matola Rio) in Boane will increase by 10.2 times.



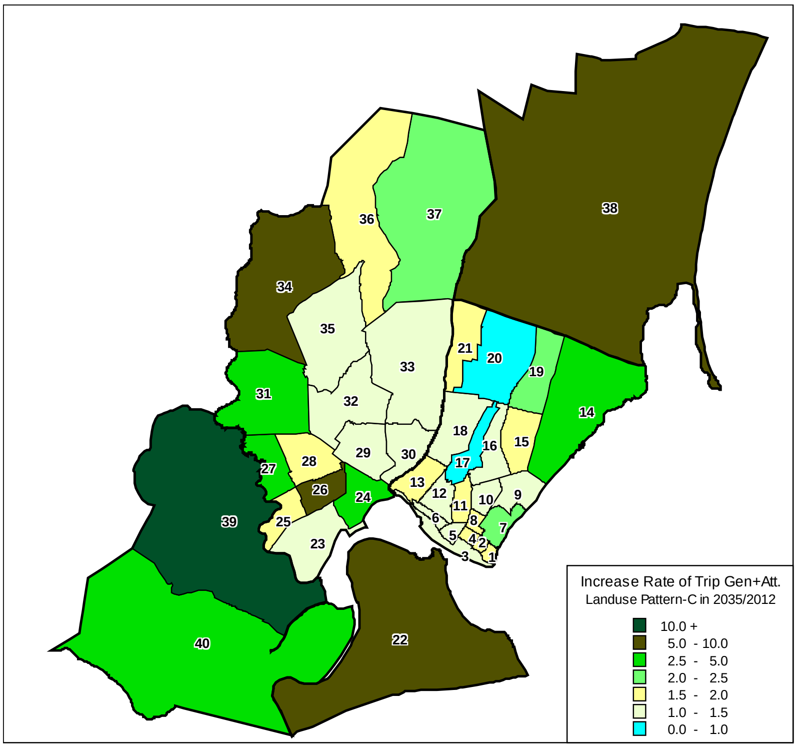
Source: JICA Project Team

Figure N.27: Classification of B-zone by Increase Rate of Trip Generation and Attraction between 2012 and 2035 (Land Use Pattern-A [Existing Trend])



Source: JICA Project Team

Figure N.28: Classification of B-zone by Increase Rate of Trip Generation and Attraction between 2012 and 2035 (Land Use Pattern-B [Polycentric Multi Core])



Source: JICA Project Team

Figure N.29: Classification of B zone by Increase Rate of Trip Generation and Attraction between 2012 and 2035 (Land Use Pattern-C [Compact Corridor])

Table N.11: Trip Generation + Attraction by Land Use Pattern

B-Zone		Generation + Attraction				Increase Rate		
		2012	Pattern-A	Pattern-B	Pattern-C	A/2012	B/2012	C/2012
Maputo	1	124,306	187,620	198,523	195,444	1.509	1.597	1.572
	2	96,789	144,350	153,127	154,387	1.491	1.582	1.595
	3	314,936	478,244	487,674	465,757	1.519	1.548	1.479
	4	188,380	299,099	310,178	307,839	1.588	1.647	1.634
	5	204,097	285,319	301,669	295,411	1.398	1.478	1.447
	6	81,145	107,726	117,356	108,219	1.328	1.446	1.334
	7	115,065	288,322	273,781	275,966	2.506	2.379	2.398
	8	114,320	175,583	185,065	183,718	1.536	1.619	1.607
	9	210,444	286,351	292,194	298,068	1.361	1.388	1.416
	10	220,570	260,889	277,806	264,815	1.183	1.259	1.201
	11	181,658	241,408	260,814	286,152	1.329	1.436	1.575
	12	341,020	389,507	446,923	453,618	1.142	1.311	1.330
	13	194,218	341,189	337,707	354,671	1.757	1.739	1.826
	14	82,030	153,218	220,879	387,057	1.868	2.693	4.718
	15	234,650	348,392	327,702	359,796	1.485	1.397	1.533
	16	284,213	497,147	327,572	313,485	1.749	1.153	1.103
	17	722	653	493	604	0.904	0.683	0.837
	18	362,078	614,967	428,687	420,514	1.698	1.184	1.161
	19	152,359	334,770	353,878	372,555	2.197	2.323	2.445
	20	189,952	315,951	238,815	152,909	1.663	1.257	0.805
	21	151,950	257,419	267,710	276,861	1.694	1.762	1.822
	22	51,552	81,292	294,647	361,328	1.577	5.716	7.009
	Total	3,896,454	6,089,416	6,103,200	6,289,174	1.563	1.566	1.614
Matola	23	209,199	466,019	302,816	252,786	2.228	1.448	1.208
	24	60,228	344,864	238,083	278,703	5.726	3.953	4.627
	25	94,150	236,788	183,341	186,727	2.515	1.947	1.983
	26	165,671	1,157,847	1,050,924	1,047,633	6.989	6.343	6.324
	27	56,913	190,854	166,330	172,111	3.353	2.923	3.024
	28	120,517	307,354	228,814	222,269	2.550	1.899	1.844
	29	236,208	533,412	311,727	349,210	2.258	1.320	1.478
	30	168,523	383,874	226,195	220,817	2.278	1.342	1.310
	31	148,538	305,341	474,996	500,261	2.056	3.198	3.368
	32	168,119	366,823	189,558	186,266	2.182	1.128	1.108
	33	320,693	757,554	452,791	392,911	2.362	1.412	1.225
	34	36,175	163,429	412,684	181,003	4.518	11.408	5.004
	35	52,616	136,921	186,779	65,011	2.602	3.550	1.236
	36	12,546	29,441	20,677	20,127	2.347	1.648	1.604
	37	41,258	125,435	101,804	102,770	3.040	2.467	2.491
	Total	1,891,354	5,505,956	4,547,519	4,178,605	2.911	2.404	2.209
Marracuene	38	214,204	705,071	1,021,403	1,114,580	3.292	4.768	5.203
Boane	39	93,599	409,309	785,168	951,025	4.373	8.389	10.161
	40	103,868	285,843	538,318	462,216	2.752	5.183	4.450
	Total	197,467	695,152	1,323,486	1,413,241	3.520	6.702	7.157
Grand Total		6,199,479	12,995,595	12,995,608	12,995,600	2.096	2.096	2.096

Source: JICA Project Team

N.2.3 Trip Distribution

The second step of the four-stage model calculates the number of trips made between zones within a study area. In this survey, the trips between zones were firstly calculated, followed by the trips within zones.

(1) Trip Distribution Models

Trip Distribution Model

The trip distribution model is developed by applying the Voorhees type Gravity model. The parameters by trip purpose are shown in Table N.12.

$$T_{ij} = G_i \frac{A_j \times D_{ij}^{\alpha}}{\sum\left(A_j \times D_{ij}^{\alpha}\right)}$$

Where
Tij: *Trips between zone i and j*
Gi: *Generated trip from zone i*
Aj: *Attracted trip to zone j*
Dij: *Distance between zone i and j*
α: *Parameter*

Table N.12: Parameters of Trip Distribution Models

Purpose	Not Car Owning		Car Owning	
	α	Correlation Coefficient	α	Correlation Coefficient
To Work	0.5342	0.886	0.0957	0.808
To School	0.2841	0.610	0.6152	0.745
Business	0.2480	0.673	0.1750	0.668
Private	0.4930	0.744	0.3501	0.728
To Home	0.4153	0.802	0.2321	0.802

Source: JICA Project Team

Intra Trip Model

Intra trip models are developed by linear regression analysis, and the variables and parameters are shown in Table N.13.

$$\frac{T_{ii}}{A} = a_1 \frac{G_i}{A} + a_2 \frac{A_i}{A} + a_3 D + a_4$$

Where,
Tij: *Intra trip in zone i*
Gi: *Generated trip from zone i*
Ai: *Attracted trip to zone i*
A: *Area of zone i*
D: *Dummy variable*
a_1-a_4: *Parameter*

Table N.13: Parameters of Intra Trip Models

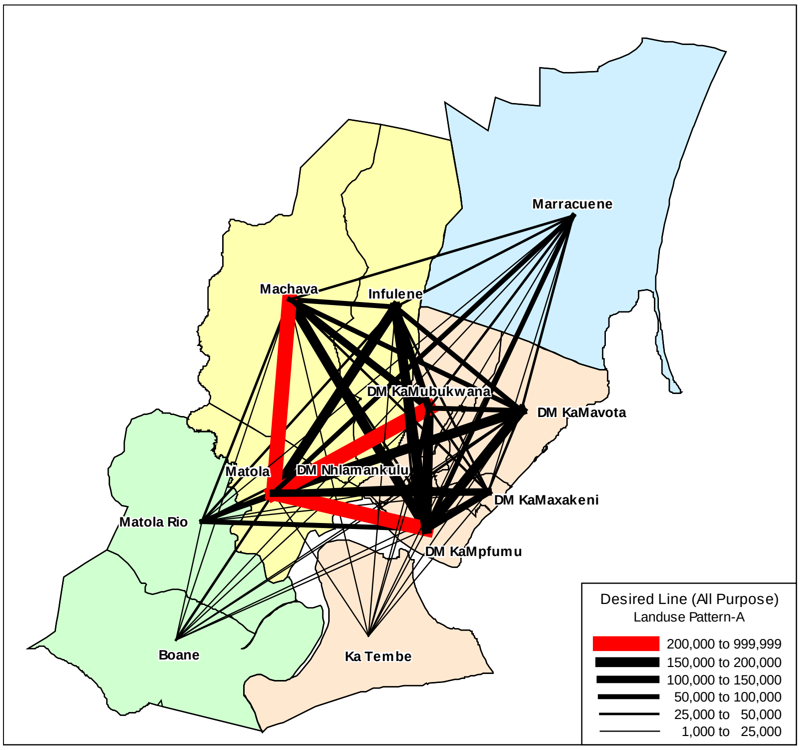
		a_1	a_2	a_3	Dummy (Zone No.)	a_4	Correlation Coefficient
Not Car-owing	To Work	0.2024	0.0073			62.719	0.935
	To School	0.4492		1,282.391	10		0.972
	Business	0.0330		193.492	16		0.940
	Private	0.2919		892.529	12		0.971
	To Home		0.3248			31.881	0.947
Car-owning	To Work	0.0909	0.0460	1,149.920	4		0.990
	To School	0.1726	0.0220			26.859	0.916
	Business	0.0417		1,677.035	4		0.974
	Private	0.1637	0.0503			9.098	0.949
	To Home	0.0155	0.2020			0.146	0.956

Source: JICA Project Team

(2) Trip Distribution in 2035

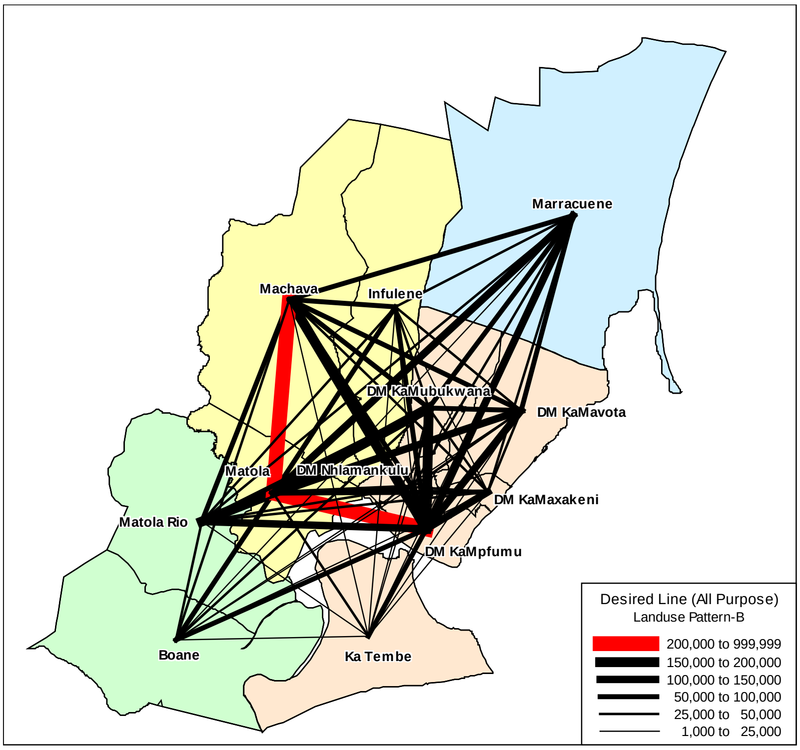
Figure N.30 to Figure N.32 show the future trip distribution in desired lines for each of the three land use patterns. Comparing these three future figures with the present Figure N.16, the centre of Greater Maputo will shift from DM KaMpfumu to Matola. With this change, the number of trips between DM KapMfumu and Matola is expected to increase significantly.

In the case of land use pattern A with existing trends, trips within Maputo municipality will not increase significantly, but there will be a considerable increase of trips that originate from outside of Maputo municipality flowing into Maputo city centre and also trips within Matola. For patterns B and C, trips coming into Maputo from KaTembe, Marracuene, Boane will increase, while the trips within Matola and Maputo will decrease. Comparing pattern C with pattern B, pattern C shows the trips in the northern part of Matola will decrease, and long distance trips between zones will decrease, but short distance trips will increase.



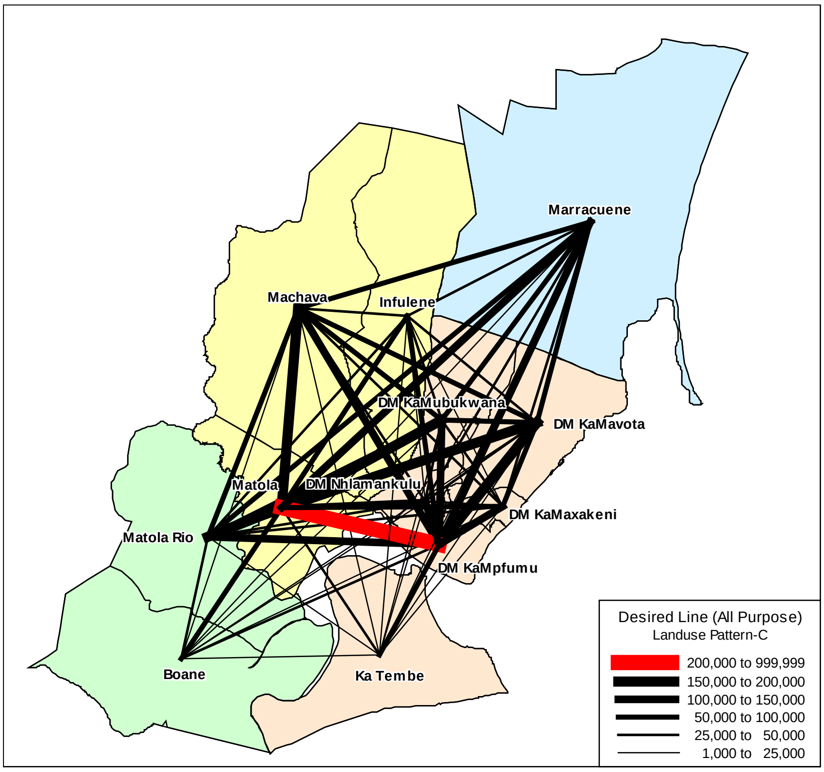
Source: JICA Project Team

Figure N.30: Desired Line (All Purpose) in 2035 (Land Use Pattern-A [Existing Trend])



Source: JICA Project Team

Figure N.31: Desired Line (All Purpose) in 2035 (Land Use Pattern-B [Poly-Centric Multi Core])



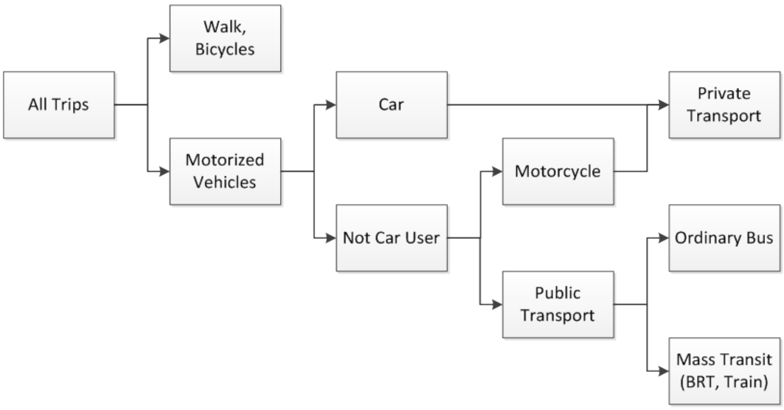
Source: JICA Project Team

Figure N.32: Desired Line (All Purpose) in 2035 (Land Use Pattern-C [Compact Corridor])

N.2.4 Modal Split

Modal split (or modal choice), the third step in the four-stage transport forecasting model, is the process of determining which form of transport is used by travellers. Although the HIS classified the type of travel mode into 17 categories, forecasting traffic demand in line with this categorization was unrealistic. Therefore, the mode of travel was integrated into three types required to consider the master plan. These are walk/bicycles, private transport (motorcycle/car/taxi/truck), and public transport (chapas/bus/ferry/etc.).

A binary choice structure was used in the modal choice stage. As shown in Figure N.33, trips were first divided into walk/bicycles and others. Second, these “others” were divided into private transport and others. The third step separated the motorcycle from public transport based on the Stated Preference (SP) survey. The motorcycle was then combined with car and named private transport. The forth step also used the SP survey results to separate mass transit from ordinary bus.



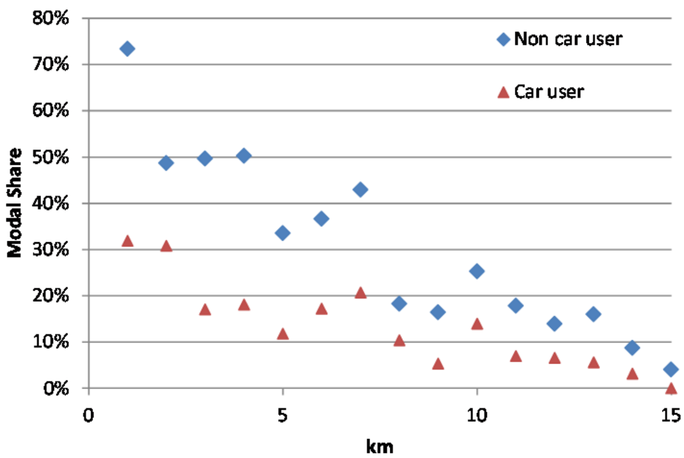
Source: JICA Project Team

Figure N.33: Binary Type Modal Choice Structure

(1) Trip Distribution Models

Walk/Bicycle model

Figure N.34 shows the modal share rate of walk/bicycle as calculated from the HIS results. The share of walk/bicycle is high for households without car ownership. Similarly, the longer the travel distance becomes, the lower the modal share is, converging to zero at the 15 km mark.



Source: JICA Project Team

Figure N.34: Binary Type Modal Choice Structure

For this distribution, the modal share rate curve is shown in Figure N.35.

$$P_{ij_{walk}} = \frac{1}{1 + e^{aD_{ij}+b}}$$

Where,

Pij_{walk}: *Modal share of walk and bicycle between zone i and j*

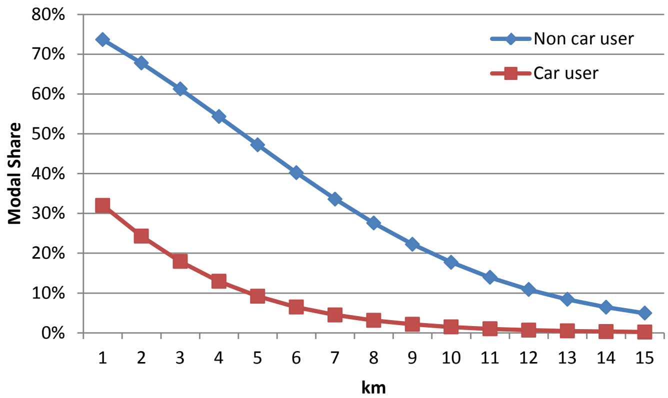
Dij: *Distance between zone i and j*

a,b: *Parameter*

Table N.14: Parameters of Modal Split Model for Walk and Bicycle

	a	b
Not Car Owing Household	0.2848	−1.3127
Car Owing Household	0.3841	0.3696

Source: JICA Project Team



Source: JICA Project Team

Figure N.35: Modal Split Curve (Walk and Bicycle)

Public Transport / Private Transport Modal Share

Using the travel time and cost as its explanatory variable, the model for public transport / private transport modal share set the following curve.

$$P_{ij\,bus} = \frac{1}{1 + \exp\left\{a\left(T_{ij}^{car} - T_{ij}^{bus}\right) + b\left(C_{ij}^{car} - C_{ij}^{bus}\right) + c\right\}}$$

Where,

Pij_{walk}:	*Modal share of public transportation between zone i and j*
$T^{Car}ij$:	*Travel time between zone i and j by cars (minutes)*
$T^{Bus}ij$:	*Travel time between zone i and j by public transport (minutes)*
$C^{Car}ij$:	*Travel cost between zone i and j by cars (MT)*
$C^{Bus}ij$:	*Travel cost between zone i and j by public transport (MT)*
a,b,c:	*Parameter*

Parameters were calculated from the current OD table, and from the modal share rate, travel time and cost derived from the network data (Table N.15).

Table N.15: Parameters of Modal Split Model for Public Transport and Private Transport

	a	b	c
Not Car Owing Household	−0.0101	–	−1.6601
Car Owing Household	−0.0018	−0.0091	0.0680

Source: JICA Project Team

Forecasting of Future Motorcycle Users

In the SP survey, the following questions were asked to travellers who used public transport such as buses and chapas and did not own motorcycles.

Q1: If your income increases, would you like to use motorcycle to go to work / school?

Q2: (If replied "yes" to Q1) To buy a motorcycle, how much more would your income have to be compared to your current income?

The replies obtained are shown in Table N.16.

Table N.16: Part of Answers of SP Survey

Q1	Responded Answers	
Yes	122	20%
No	477	80%
Total	599	100%

Q2	Responded Answers
1.2 times	64
1.5 times	5
2.0 times	12
2.5 times	4
3.0 times	3
3.5 times	8
4.0 times	5
Over 4 times	10
Unknown	11
Total	122

Source: JICA Project Team

As shown in Table N.4, the GRDP per capita in 2035 is expected to be 2.3 times that of 2012. The replies to Q2 showed that 83 people out of 111 (75%), in other words, 20% of those who use public transport and are from households with no car, have the possibility of using a motorcycle. Therefore, after creating a public transport OD chart using the modal share rates, 15% (=0.2 * 0.75) are converted to motorcycle and the remaining 85% use public transport.

Mass Public Transport / Ordinary Bus model share

Of the 85% of trips after removing the motorcycle users, mass transport such as BRT and railway were separated from ordinary bus by using the share model derived from the SP survey results (See Technical Report L.1.3 (3) Stated Preference Model).

$$P_{ij_{BRT}} = \frac{1}{1 + \exp\{a(A_i^{bus} - A_i^{BRT}) + b(T_{ij}^{bus} - T_{ij}^{BRT}) + c(C_{ij}^{bus} - C_{ij}^{BRT}) + d\}}$$

Where,

Pij_{BRT}:	*Modal share of mass-transit systems between zone i and j*
$A^{bus}i$:	*Access time from zone i to the nearest bus stop (minutes)*
$A^{BRT}i$:	*Access time from zone i to the nearest BRT station (minutes)*
$T^{bus}ij$:	*Travel time between zone i and j by ordinary bus (minutes)*
$T^{BRT}ij$:	*Travel time between zone i and j by mass-transit systems (minutes)*
$T^{bus}ij$:	*Travel time between zone i and j by ordinary bus (minutes)*
$C^{BRT}ij$:	*Travel cost between zone i and j by mass-transit systems (MT)*
$C^{bus}ij$:	*Travel cost between zone i and j by ordinary bus (MT)*
a,b,c,d:	*Parameter*

Table N.17: Parameters of Modal Split Model for Mass-transit Systems and Ordinary Bus

	a	b	c	d
Not Car Owning household	0.0063	−0.0016	−0.0479	−1.3859

Source: JICA Project Team

(2) Modal Share in 2035

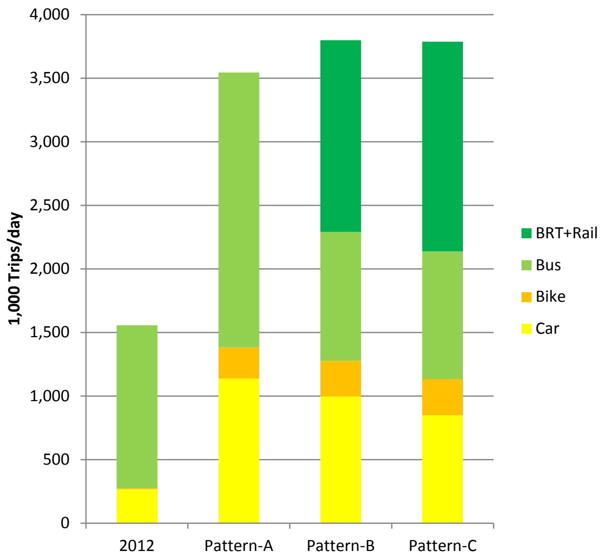
Examining the modal share in 2035 and comparing it to that of 2012, the growth rate for each mode is shown below. Walk trips will increase by 1.9 to 2.1, by car will increase by 3.2 to 4.3, by motorcycle by 35.0 to 40.6, by public transport by 1.7 to 2.1.

In terms of the land use patterns, Pattern A shows a large number using cars, but in Patterns B and C, the share of cars decrease, and public transport share increases. Comparing Patterns B and C, Pattern C has a decrease in the share of cars, but increase in the share of public transport.

Table N.18: Results of Modal Share by Land-use Pattern

		2035 by land-use					
	2012	Pattern-A		Pattern-B		Pattern-C	
Mode	1,000 trips/day	1,000 trips/day	Growth Rate	1,000 trips/day	Growth Rate	1,000 trips/day	Growth Rate
Car	267 (17%)	1,137 (32%)	4.3	997 (26%)	3.7	848 (22%)	3.2
Bike	7 (0%)	245 (7%)	35.0	280 (7%)	40.0	284 (7%)	40.6
Bus	1,282 (83%)	2,162 (61%)	1.7	1,013 (27%)	0.8	1,005 (27%)	0.8
BRT+Railway	0 (0%)	0 (0%)	-	1,508 (40%)	-	1,650 (44%)	-
Public transport	1,282 (83%)	2,162 (61%)	1.7	2,521 (67%)	2.0	2,655 (71%)	2.1
Total	1,556 (100%)	3,544 (100%)	2.3	3,798 (100%)	2.4	3,787 (100%)	2.4

Source: JICA Project Team



Source: JICA Project Team

Figure N.36: Result of Modal Share by Land-use Pattern

N.2.5 Traffic Assignment

Traffic assignment is the final stage of the four-stage travel demand model. In the three previous stages, the number of trips by each mode between each pair of zones has been found. In the assignment stage, the trips are allocated to links through the network and the future traffic volume is calculated for each link. The basic premise of assignment is that each traveller chooses the route which offers him or her the minimum perceived cost.

For this study, the public transport OD traffic was first assigned onto the transport network, then private transport OD traffic assigned. To provide more detail, public transport OD was assigned prioritizing mass public transport, then for the OD traffic exceeding the capacity would be considered ordinary bus users and assigned onto the road. Then the traffic volume for each link for the buses assigned to the road were used as the initial traffic volume in assigning private vehicle OD chart, then assignment calculation was conducted.

(1) Conversion from Trip Base OD to PCU Base OD

The shares for the future OD chart are trip-based. Using average number of passengers and PCU (passenger car unit), this was converted to PCU based OD.

Table N.19: Average Number of Passengers

	Avg. Pax. Number	PCU	Remarks
Car	2.1	1.0	using of HIS results
Truck	2.5	2.5	using of result of cordon and logistics survey
Ordinary Bus	50	2.0	For large bus
BRT	170	-	For 2-car (single articulated) bus
Train	1,700	-	For 10-car train

Source: JICA Project Team

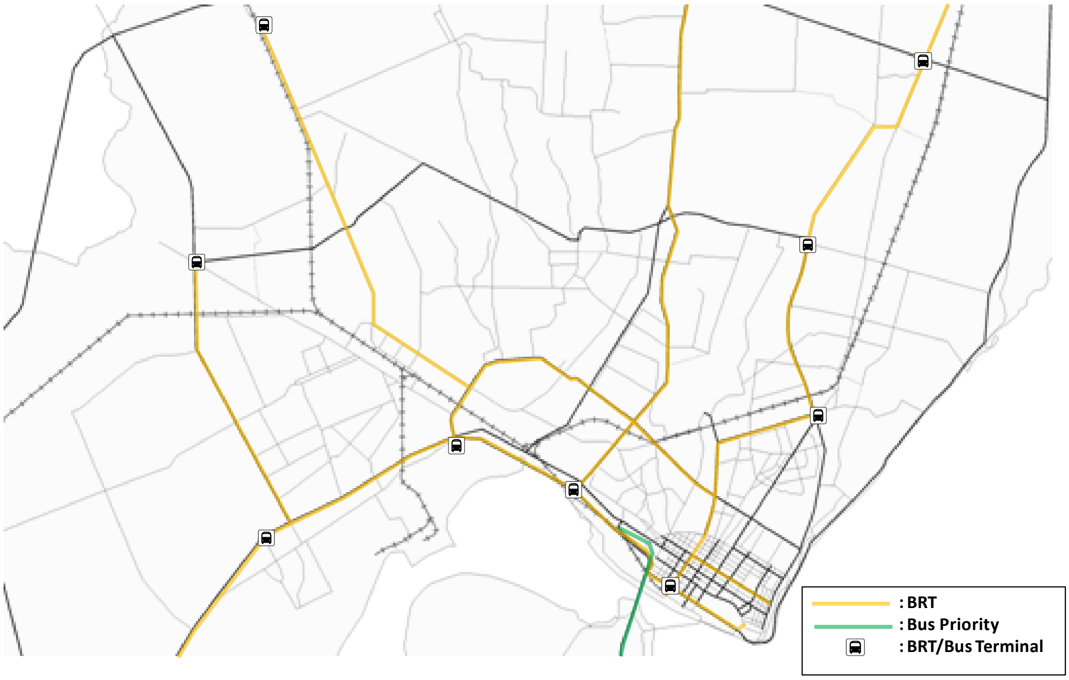
(2) Future Transport Network

The following three patterns were used for the future transport network (Figure N.37, Figure N.38, and Figure N.39).

- Do Minimum Network
- Do Intermediate Network with BRT network
- Do Maximum Network with BRT + Railway networks

Source: JICA Project Team

Figure N.37: Do Minimum Network in 2035



Source: JICA Project Team

Figure N.38: Do Intermediate Network in 2035

Source: JICA Project Team

Figure N.39: Do Maximum Network in 2035

(3) Assignment Case

Assignment was done for 3 cases as shown below.

Table N.20: Assignment Case

Assignment case	OD Type (Land use Pattern)	Network Type
Case-1	A: Existing Trend	Do Minimum
Case-2	B: Poly-centric Multi core	Do Intermediate
Case-3	C: Compact Corridor	Do Maximum

Source: JICA Project Team

(4) Network Link Capacity

This means that routes including links at or above capacity may not be the shortest under congested conditions. The capacity of the network link was calculated using the correction coefficient (below) on the base capacity of one lane (2,000 vehicles/hour), using time coefficient (K) and directional coefficient (D), converting it to the per day figure.

- Correction coefficient for areas
  DID 0.6
  Urban 0.8
  Flat 1.0
  Mountain 1.0

- Correction coefficient based on the service level of road specifications
  National road 0.6
  Arterial road 0.75
  Supplementary arterial road 0.85

- Correction coefficient based on the road surface condition
  Good 1.0
  Fair 0.9
  Bad 0.8
  Very bad 0.7

- Peak hour coefficient (K)
  DID 9.1
  Others 9.3

- Directional coefficient (D)
  Radial Road 66%
  Others 52%

QV chart created is shown in Table N.21.

For BRT and railway, the capacity was set based on the maximum passenger capacity per day per car to do trip-based assignments. (Table N.22)

Table N.21: QV Table

Road Type	Area	Max. Speed	2-lane/ 2 directions	Radial Road			Other Road		
				2-lane	4-lane	6-lane	2-lane	4-lane	6-lane
National Road/ Principal Arterial Road	DID	40	9,900	13,200	26,400	39,600	16,700	33,500	50,200
		40	8,900	11,900	23,700	35,600	15,100	30,100	45,200
		40	7,900	10,600	21,100	31,700	13,400	26,800	40,200
		40	6,900	9,200	18,400	27,700	11,700	23,400	35,100
		40	8,900	11,900	23,700	35,600	15,100	30,100	45,200
		40	8,000	10,700	21,400	32,100	13,600	27,100	40,700
		40	7,100	9,500	19,000	28,500	12,000	24,100	36,100
		40	6,200	8,300	16,600	24,900	10,500	21,100	31,600
		40	7,900	10,600	21,100	31,700	13,400	26,800	40,200
		40	7,100	9,500	19,000	28,500	12,000	24,100	36,100
		40	6,300	8,400	16,900	25,300	10,700	21,400	32,100
		40	5,500	7,400	14,800	22,200	9,400	18,800	28,100
	URBAN	50	12,900	17,200	34,400	51,600	21,800	43,700	65,500
		50	11,600	15,500	31,000	46,400	19,600	39,300	58,900
		50	10,300	13,800	27,500	41,300	17,500	34,900	52,400
	FLAT	60	16,100	21,500	43,000	64,500	27,300	54,600	81,900
		60	14,500	19,400	38,700	58,100	24,600	49,100	73,700
		60	12,900	17,200	34,400	51,600	21,800	43,700	65,500
	Mountain	60	16,100	21,500	43,000	64,500	27,300	54,600	81,900
		60	14,500	19,400	38,700	58,100	24,600	49,100	73,700
		60	12,900	17,200	34,400	51,600	21,800	43,700	65,500
Arterial Road	DID	35	12,400	16,500	33,000	49,500	20,900	41,800	62,800
		35	11,100	14,800	29,700	44,500	18,800	37,700	56,500
		35	9,900	13,200	26,400	39,600	16,700	33,500	50,200
		35	8,700	11,500	23,100	34,600	14,600	29,300	43,900
		35	11,100	14,800	29,700	44,500	18,800	37,700	56,500
		35	10,000	13,400	26,700	40,100	16,900	33,900	50,800
		35	8,900	11,900	23,700	35,600	15,100	30,100	45,200
		35	7,800	10,400	20,800	31,200	13,200	26,400	39,600
		35	9,900	13,200	26,400	39,600	16,700	33,500	50,200
		35	8,900	11,900	23,700	35,600	15,100	30,100	45,200
		35	7,900	10,600	21,100	31,700	13,400	26,800	40,200
		35	6,900	9,200	18,400	27,700	11,700	23,400	35,100
	URBAN	45	16,100	21,500	43,000	64,500	27,300	54,600	81,900
		45	14,500	19,400	38,700	58,100	24,600	49,100	73,700
		45	12,900	17,200	34,400	51,600	21,800	43,700	65,500
	FLAT	55	20,200	26,900	53,800	80,600	34,100	68,200	102,400
		55	18,200	24,200	48,400	72,600	30,700	61,400	92,100
		55	16,100	21,500	43,000	64,500	27,300	54,600	81,900
	Mountain	50	20,200	26,900	53,800	80,600	34,100	68,200	102,400
		50	18,200	24,200	48,400	72,600	30,700	61,400	92,100
		50	16,100	21,500	43,000	64,500	27,300	54,600	81,900
Minor Arterial Road	DID	30	14,000	18,700	37,400	56,000	23,700	47,400	71,100
		30	12,600	16,800	33,600	50,400	21,300	42,700	64,000
		30	11,200	15,000	29,900	44,900	19,000	38,000	56,900
		30	9,800	13,100	26,100	39,200	16,600	33,200	49,800
		30	12,600	16,800	33,600	50,400	21,300	42,700	64,000
		30	11,400	15,100	30,300	45,400	19,200	38,400	57,600
		30	10,100	13,500	26,900	40,400	17,100	34,200	51,200
		30	8,800	11,800	23,500	35,300	14,900	29,900	44,800
		30	11,200	15,000	29,900	44,900	19,000	38,000	56,900
		30	10,100	13,500	26,900	40,400	17,100	34,200	51,200
		30	9,000	12,000	23,900	35,900	15,200	30,300	45,500
		30	7,800	10,500	20,900	31,400	13,300	26,500	39,800
	URBAN	40	18,300	24,400	48,700	73,100	30,900	61,900	92,800
		40	16,500	21,900	43,900	65,800	27,800	55,700	83,500
		40	14,600	19,500	39,000	58,500	24,800	49,500	74,300
	FLAT	50	22,800	30,500	60,900	91,400	38,700	77,300	116,000
		50	20,600	27,400	54,800	82,300	34,800	69,600	104,400
		50	18,300	24,400	48,700	73,100	30,900	61,900	92,800
	Mountain	45	22,800	30,500	60,900	91,400	38,700	77,300	116,000
		45	20,600	27,400	54,800	82,300	34,800	69,600	104,400
		45	18,300	24,400	48,700	73,100	30,900	61,900	92,800

Source: JICA Project Team

Table N.22: QV Table for BRT and Railway

	Maximum Passengers (pax/day)	Scheduled Speed (km/h)
BRT	83,000	30
Railway	520,000	40

Source: JICA Project Team

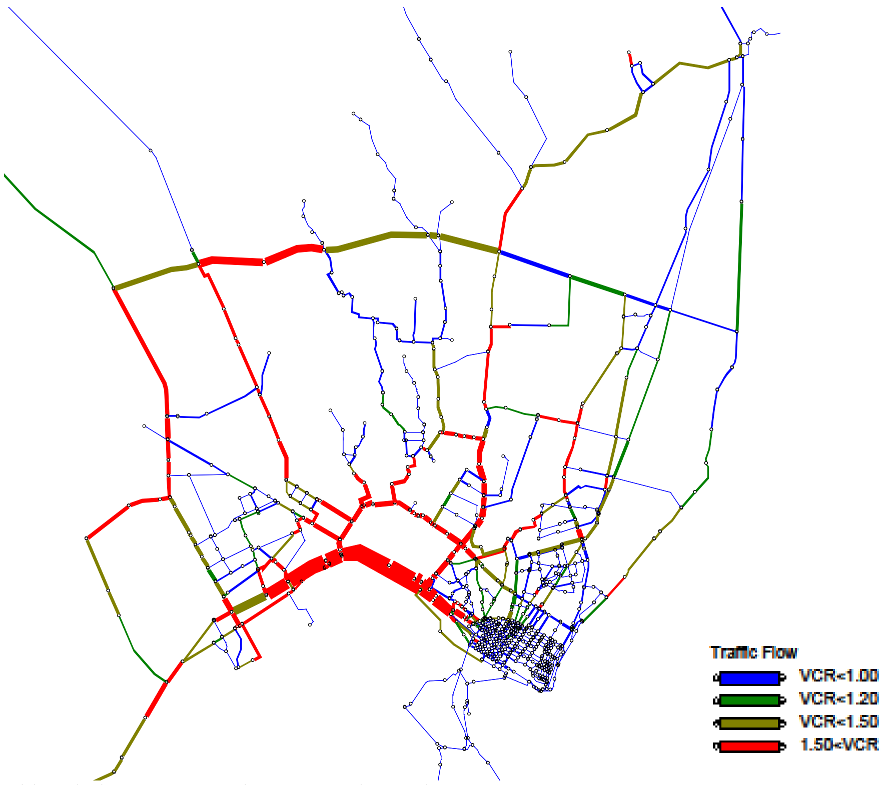
(5) Trip Assignment in 2035

Figure N.40 to Figure N.42 show the results of the OD matrix made based on the three land use patterns, assigned to three network types.

In the "Do Minimum Case" (Figure N.40) in which only the existing roads and current constructing roads are used, there is heavy congestion expected in the main arterial roads in 2035. The ring road will even have sections with more than 1.5 in the level of congestion. For the N4 road between Maputo and Matola, 160,000 PCU/day is expected.

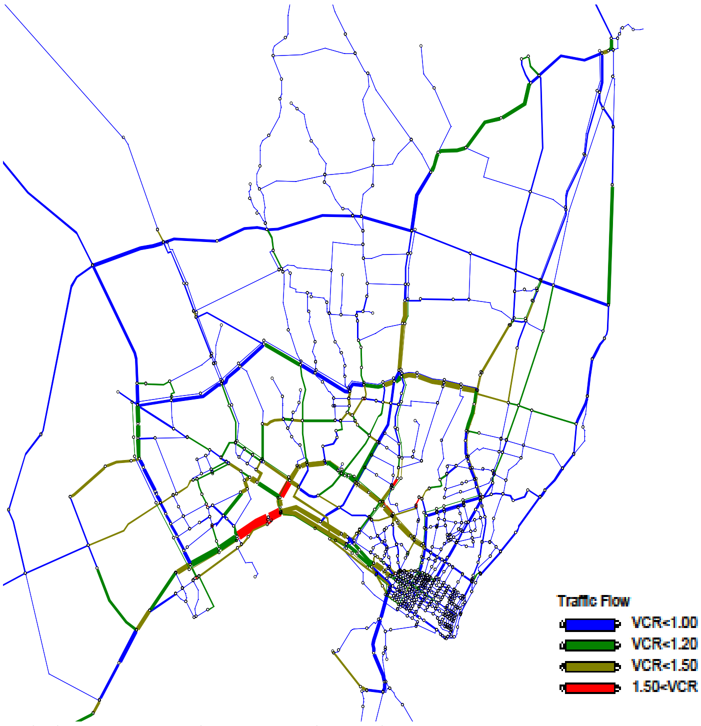
In the "Do Intermediate Case" (Figure N.41) in which BRT is developed, much of the congestion shown in the "Do Minimum Case" is eased. However, for one section of the N4 road between Maputo and Matola, the traffic volume will reach 100,000 PCU/day, and the level of congestion is expected to exceed 1.5.

The "Do Maximum Case" (Figure N.42), having both BRT and railway development, shows all links with congestion less than 1.5. The maximum traffic volume on N4 between Maputo and Matola is 80,000 PCU/day, and the level of congestion at 1.2.



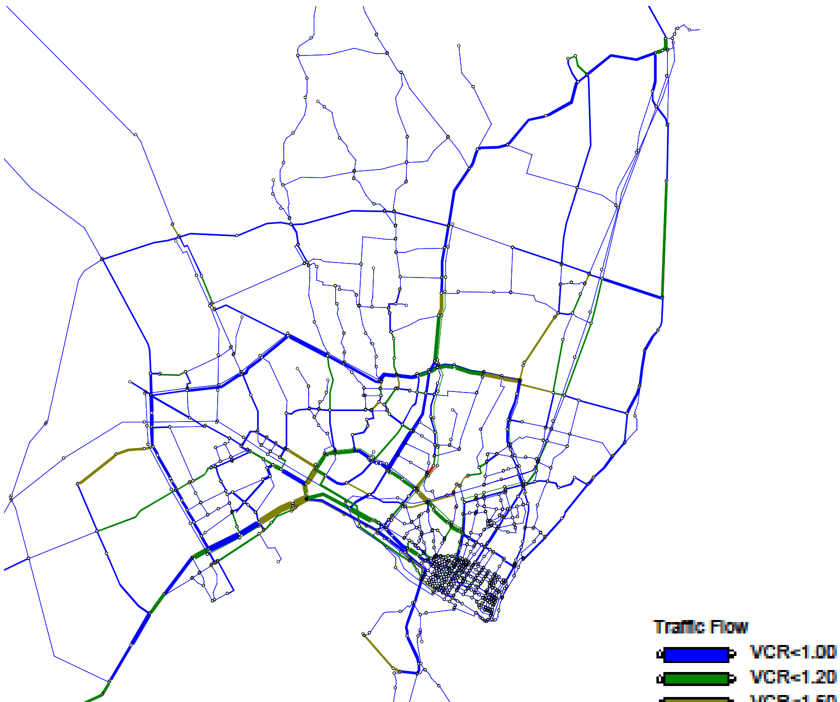
Abbreviation: VCR = Volume-Capacity Ratio
Source: JICA Project Team

Figure N.40: Case-1 (Existing Trend Type OD+ Do Minimum Network) in 2035



Abbreviation: VCR = Volume-Capacity Ratio
Source: JICA Project Team

Figure N.41: Case-2 (Poly-centric Multi Core Type OD+ Do Intermediate Network) in 2035



Abbreviation: VCR = Volume-Capacity Ratio
Source: JICA Project Team

Figure N.42: Case-3 (Compact Corridor Type OD + Do Maximum Network) in 2035

Technical Report O

Multi-Criteria Analysis and Economic Evaluation

Contents

Figures

Tables

Technical Report O Multi-Criteria Analysis and Economic Evaluation

O.1 Introduction

O.1.1 Purpose

This Technical Report outlines the approach and assumptions adopted and the results from the multi-criteria analysis to select the preferred scenario, as well as of the economic evaluation of that scenario against the "Do Minimum" scenario.

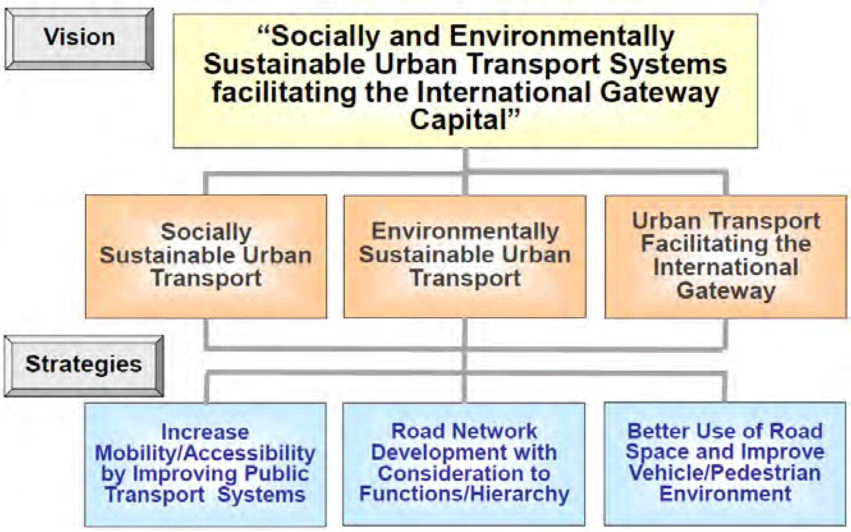
O.1.2 Structure

Subsequent Sections of this Technical Report are structured as follows:

- Section O.2 introduces and outlines the approach taken to scenario selection
- Section O.3 sets out the urban transport goals
- Section O.4 outlines the alternative land use/ transport scenarios
- Section O.5 discusses the evaluation of alternative scenarios
- Section O.6 discusses the preferred transport network scenario
- Section O.7 introduces and outlines the approach taken to economic evaluation of the preferred scenario
- Section O.8 describes how parameters were defined for economic analysis
- Section O.9 presents project cost data
- Section O.10 shows the economic evaluation results

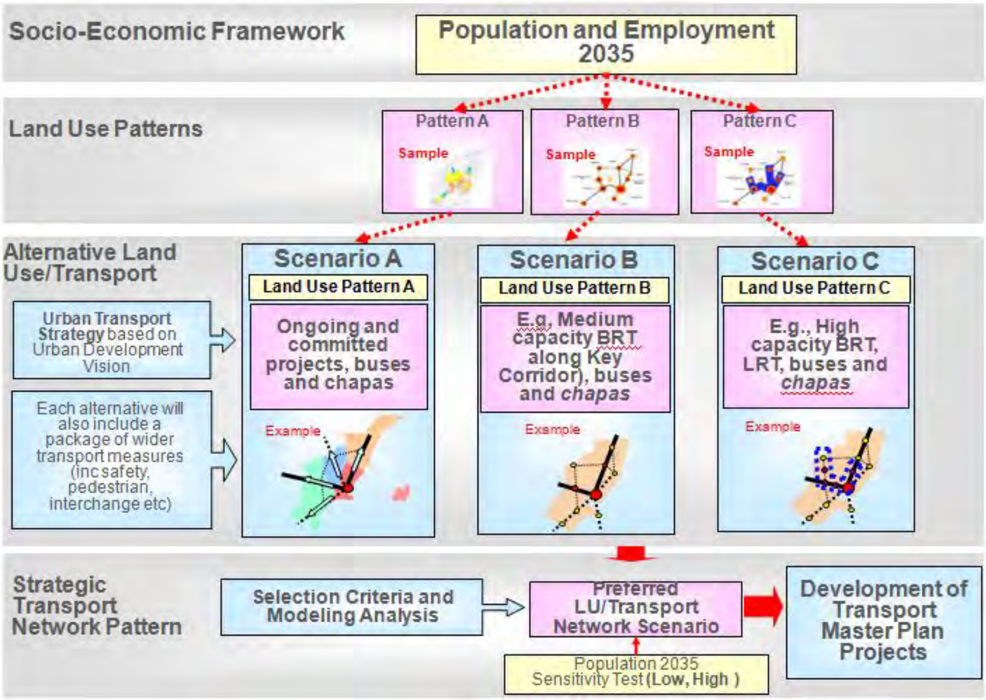
O.2 Introduction for Scenario Selection

Sections O.2 to O.6 set out the works undertaken to select the preferred land use and transport scenario. The overall urban transport development vision and strategy is as set out in Figure O.1. An overview of the workflow is shown in Figure O.2.



Source: JICA Project Team

Figure O.1: Urban Transport Development Vision and Strategy



Source: JICA Project Team

Figure O.2: Workflow for Development and Evaluation of Scenarios

As can be seen in Figure O.2, the choices from which the preferred scenario is selected are as follows:

- Land Use Pattern A (existing trend) with Transport Network Scenario A, i.e. do nothing (though ongoing and already committed projects are included)
- Land Use Pattern B (poly-centric development) with Transport Network Scenario B, i.e. reform of buses and chapas and the development of Bus Rapid Transit (BRT)
- Land Use Pattern C (development intensification along key transit corridors) with Transport Network Scenario C, i.e. development of heavy commuter rail in addition BRT, with bus and chapa networks restructured accordingly

The remainder of this Technical Report is structured as follows:

- Section O.3 sets out the urban transport goals and strategies.
- Section O.4 presents the alternative land use/transport scenarios
- Section O.5 describes the evaluation of these alternative scenarios
- Section O.6 describes the transport network taken into the Master Plan.

O.3 Urban Transport Goals and Strategies

O.3.1 Outline

Urban transport in Maputo currently faces a number of issues compromising the level-of-service offered to trip-makers, car-users, public transport passengers or even pedestrians. In order to formulate appropriate plans to upgrade and improve urban transport, addressing the most pressing issues, it is necessary to first identify which are the key goals, followed by the formulation of strategies to potentially address these. Finally, to assess the extent to which these strategies are likely to address the issues identified and achieve the desired goals.

The development of the Comprehensive Urban Transport Master Plan for the Greater Maputo Region was conducted in two broad phases, as follows:

- Firstly, selection of the preferred land use/transport scenario, with a broad set of transport strategies and goals inferred; and,
- Secondly, refinement of the preferred scenario and fine-tuning of the transport strategies, including more detailed investigation of performance against stated goals.

Sub-Section O.3.2 set out the key challenges faced, according to sector. Based upon these, system performance indices are then defined in Sub-Section O.3.4 for testing as set out in Section O.5.

O.3.2 Key Challenges

(1) Institutional and Financial Challenges

The key institutional and financial challenges identified are as follows:

- Need for capacity building, institutional strengthening and human capital development, in order to:
  - Enable decision making and consensus between agencies
  - Better manage transport networks and operations, including maintenance and planning functions
  - Define land use policy and enforcing the planning regulations
- Strengthen municipality and district finances to be able to implement development plans and projects (both capital expenditure and recurrent expenditure to maintain)

(2) Road Network Challenges

At present only part of the road network is paved. And even where paved, roads are often poorly maintained. The road network challenges can be summarized thus:

- Need to upgrade road network, increasing the amount of paved network
- Improve road maintenance
- Reduce vulnerability to flooding – improve drainage
- Improve road safety

(3) Public Transport Challenges

The Household Interview Survey (HIS) data showed that, excluding walk-only trips, approximately 85% of trips entailed the use of public transport. As such, public transport users constitute the vast majority of trip-makers within Greater Maputo.

Best practice to ensure the attractiveness of public transport requires in short that journey times, costs and general inconvenience and discomfort are minimised for public transport users (and for potential users of public transport so as to encourage use of public transport by current car users). This includes not only reducing overall journey times, but also minimising in particular walking times and distances required to access and egress public transport, as well as the number of interchanges required. Waiting times should also be minimized.

The following public transport challenges were identified to assist in the selection of the preferred scenario:

- Improve reliability and efficiency of services and vehicles
- Increase passenger capacity
- Improve stops and terminals
- Review bus and chapa fare policy
- Improve financial sustainability of operation
- Review of chapa regulation and enforcement

(4) Traffic Management, Safety and Pedestrian Environment

The key challenges for improving traffic management, safety and the pedestrian environment are as follows:

- Enforcement of regulations
  - On-street parking
  - Accidents
- Improvement of traffic management and control system
  - Traffic calming
  - Junction signal
  - Roundabout
- Introduction of TDM measures
- Improvement of road safety and pedestrian safety schemes
- The following criteria can be used to evaluate the quality of public transport on offer

O.3.3 Overview of Objectives and Strategy

The broad transport strategy can be generalized based upon the following seven points:

1) Introduce mass transit systems (Commuter Rail, LRT, BRT) with a higher level of service by harmonization with surrounding environment
2) Make public transport more convenient, faster, more comfortable, cleaner, and safer for all users (including children, elderly, disabled)
3) Improve public transport infrastructure including terminals, intermodal facilities, bus priority lanes and exclusive bus right of way where appropriate with effective utilization of resources, including lands
4) Ensure use of appropriately specified vehicles for each type of service
5) Develop and enforce appropriate regulations, and formalize public transport industry structure in order to become as a good practice for other cities of Mozambique and other countries
6) Implement financially sustainable fare structure
7) Improve institutional capacity

Based upon adoption of the above seven elements, the anticipated outcomes would be:

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

O.3.4 System Performance Indices and Scoring

(1) Balanced Score Card Methodology

The Balanced Score Card (BSC) enables different criteria developed in a multi-criteria assessment framework to be scored and combined, in order to identify the preferred scenario.

Prior to appraising individual scenarios, the system performance indices are defined, against which scenarios are tested. Without using a BSC, such a multi-criteria assessment approach may produce conflicting signals regarding the performance of each scenario. It is quite rare for example, for a single scenario to score best against each system performance index defined.

However, under a BSC approach, a weighting is assigned to each system performance index before the appraisal is undertaken. These weights are designed to reflect the relative importance of each criterion; thus making it possible to choose from amongst alternative scenarios where different scenarios score highest for different criteria.

(2) Definition of System Performance Indices

Based on the challenges presented in Section O.3.2, system performance indices were defined against which scenarios were tested. The criteria included were as follows:

Public Transport Mode Share

Public transport mode share was adopted as a system performance index, with the highest mode share being seen as best. The Comprehensive Urban Transport Master Plan for Greater Maputo seeks to increase – or in the worst case to reduce the shift away from – public transport usage.

Mode share is defined as the number of trips by a particular mode or group of modes, divided by the total number of trips. In this case public transport trips comprised rail-based, bus-based (including chapa) and where appropriate BRT-based trips. Non-public transport trips comprised car trips; trips made by goods vehicles were excluded (although trips made by *caixa aberta* were included as a form of chapa, i.e. bus trip).

Public Transport Passenger Trip Characteristics

Three inter-related metrics of public transport journeys were considered:

- Average journey time, including all legs of each trip as far as available from the transport model, with shorter journey times being preferred, all other things being equal, so as to signify quicker journeys by public transport;
- Average journey distance, similarly covering all legs of each trip as far as available from the transport model, with shorter journey distances being preferred, all other things being equal, so as to signify directness of public transport options for users; and,
- Average journey speed, calculated as average journey speed divided by average journey time, with higher speeds being preferred, all other things being equal, signifying a relative reduction in delays as compared to other scenarios.

The above metrics were calculated on a per passenger basis. Total public transport journey times and distances were summed and then these sums were divided by the number of public transport trips.

It should be noted that there might be certain trade-offs between these metrics and also public transport mode choice. If mode choice increases predominantly through an increase in longer-distance public transport trips, then average journey distances would increase. Conversely, if mode choice increased predominantly through an increase in shorter-distance public transport trips and assuming that these were predominantly in the relatively more congested city centre, then average journey speed might decrease. However, by assigning a weighting to each criterion, such effects can be expected to balance out and as such, make it easier to identify the scenario which performs best against these system performance indices as a whole.

Public Transport Vehicle Operating Characteristics

Three inter-related criteria concerning public transport vehicle operations were also included:

- Total public transport vehicle hours, with shorter vehicle hours being preferred, all other things being equal, signifying a lack of redundant services in the public transport route networks, a lack of delay affecting services and reduced vehicle fleet requirements as compared to scenarios where a greater number of vehicle hours were required;
- Total public transport vehicle kilometres, with shorter distances being preferred, all other things being equal, so as to signify directness of public transport services to increase the efficiency of operators; and,
- Average journey speed, calculated as total public transport vehicle hours divided by total public transport vehicle kilometres, with higher speeds being preferred, all other things being equal, signifying a relative reduction in delays affecting operators as compared to other scenarios.

As with the Public Transport Passenger Trip Characteristics, there is a similar trade-off amongst the three Public Transport Vehicle Operating Characteristics.

However, there may also be a trade-off between Public Transport Vehicle Operating Characteristics and Public Transport Passenger Trip Characteristics. From a passenger's perspective, the greater the spread of routes and the greater the service frequencies, then it is more likely that their journeys could be more direct and quicker. However, this would require operators to lay on more services, increasing their costs: whilst their effectiveness might increase, this could be at the expense of their efficiency.

Once again, use of a BSC enables these potentially contradictory objectives to be considered jointly, with different weightings being assigned to reflect the relative importance of the public transport passenger experience against the service requirements to be met by operators.

Criteria for Car Users

Three inter-related criteria concerning trips by private cars were included, as follows:

- Total car vehicle hours, with shorter vehicle hours being preferred, all other things being equal, signifying variously the total amount of car use (correlated with mode choice) and a lack of traffic congestion causing delay;
- Total car vehicle kilometres, with shorter vehicle distances being preferred, all other things being equal, signifying variously the total amount of car use (correlated with mode choice) and a lack of traffic congestion forcing drivers onto indirect routes; and,
- Average journey speed, calculated as total vehicle hours divided by total vehicle kilometres, with higher speeds being preferred, all other things being equal, signifying a relative reduction in congestion-related delays.

Once again there are inter-relationships and potential trade-offs between the three system performance indices concerning car trips. In addition, there are likely linkages between these criteria and mode choice: a higher public transport mode choice would likely reduce both total car vehicle hours and total car vehicle kilometres; and resulting decongestion effects would likely increase average car journey speeds.

Vehicle Operating Costs

Vehicle Operating Costs (VOC) are defined and discussed in more detail in Section O.8.2. They relate to the operating costs associated with vehicle usage, being a function of distance, time, speed and quality of roads which are driven upon. They typically increase in proportion to the distance driven and to the time spent driving. They typically decrease in the absence of traffic congestion (although at high speeds, not normally associated with urban traffic movements they can increase). In addition, the rougher the road surfaces, the higher VOC tend to be.

It is preferable that VOC be lower than higher, all other things being equal.

VOC were calculated by vehicle type, for the following vehicle categories used in the transport model:

- Cars
- Trucks
- Bus (including chapa and caixa aberta)
- BRT vehicles (where appropriate)

VOC for rail were not included in this analysis, as the estimation and derivation of rail operating costs used a different approach.

Resettlement

One likely negative impact of transport network development and of redefining and in particular enforcing new land use patterns is that a significant number of residences and other buildings may need to be relocated. As such, resettlement was also included as a system performance index. However, due to limited data availability, the analysis of resettlement requirements focused upon the estimated number of buildings requiring demolition as part of the highway project lists for each scenario. No data were available on public transport schemes' resettlement requirements.

CO_2 Emissions

In addition to looking at vehicle and passenger kilometrages and hours and VOCs, likely carbon emissions associated with each scenario were also investigated. As explained in more detail in Section O.8.3, carbon emissions can be calculated in a manner broadly similar to VOCs. NO_x emissions can also be modelled. However, these correlate very closely to CO_2 emissions, so only carbon emissions were considered in the scenario selection.

(3) System Performance Index Weightings

Sub-Section (2) set out the system performance indices adopted for evaluation in the scenario selection process, also discussing trade-offs between different performance indices. Weightings applied to the various categories of system performance index are shown in Table O.1. Table O.2 then sets out weightings and scoring ranges for each individual criterion.

Table O.1: Weightings by Type of System Performance Index for Scenario Selection

System Performance Index Type	Weight	Purpose
Public Transport Mode Share	15%	Assessment of the extent of promotion of public transport
Public Transport Passenger Trip Characteristics	25%	Public transport user perspectives
Public Transport Vehicle Operating Characteristics	15%	Public transport operator perspectives
Car User Criteria	15%	Car user perspectives
Vehicle Operating Costs	15%	Overall transport network efficiency
Resettlement	5%	Disruption
CO_2 Emissions	10%	Environmental perspective
Total	**100%**	

Source: JICA Project Team

Table O.2: System Performance Indices for Scenario Selection

Criterion	Weighting	Description and How to Compare between Scenarios	Scoring (0 to 100)
Public Transport Mode Share	**15%**	The percentage of passenger trips using public transport. The higher the public transport mode share the better.	100 for 100% public transport passenger. 0 of 0%. Other values scaled accordingly
Average Public Transport Passenger Journey Times	**15%**	Total time spent travelling by public transport, including walking and waiting times, then divided by number of trips. The lower the total journey time per trip the better (i.e. total journey time divided by number of public transport trips).	Maximum saving scored 100 and other values scaled accordingly.
Average Public Transport Passenger kilometres	**5%**	Total distance of all public transport trips, inclusive of walking distances, then divided by number of trips. All other things being equal, reducing passenger kilometres would be a proxy for more direct services.	Maximum saving scored 100 and other values scaled accordingly.
Average Public Transport Journey Speed	**5%**	Total Passenger kilometres divided by Total Journey Time. All other things being equal, faster journeys are better than slower journeys.	Maximum saving scored 100 and other values scaled accordingly.
Total Public Transport Vehicle Hours	**5%**	Total time spent by public transport vehicles on road network in modelled day. The lower the better.	Maximum saving scored 100; other values scaled accordingly.
Total Public Transport Vehicle kilometres	**5%**	Total distance travelled by public transport vehicles on road network in modelled day. The lower the better.	Maximum saving scored 100; other values scaled accordingly.
Average Public Transport Vehicle Speed	**5%**	Vehicle kilometres divided by vehicle hours. The higher the better.	Maximum increase scored 100; other values scaled accordingly.
Total Car Passenger Hours	**5%**	Total time spent by car passengers on road network in modelled day. The lower the better.	Maximum saving scored 100; other values scaled accordingly.
Total Car Passenger kilometres	**5%**	Total distance travelled by car passengers on road network in modelled day. The lower the better.	Maximum saving scored 100; other values scaled accordingly.

Criterion	Weighting	Description and How to Compare between Scenarios	Scoring (0 to 100)
Average Car Speed	**5%**	Passenger kilometres divided by passenger hours. The higher the better.	Maximum increase scored 100; other values scaled accordingly.
Vehicle Operating Costs (Car, Truck, Bus, Chapa)	**15%**	Total of vehicle operating costs of all vehicles on road network. Described in more detail later in Section O.8.2. The lower the better.	Maximum saving scored 100 and other values scaled accordingly.
Resettlement Costs	**5%**	Measured by the number of people affected. The lower the better	100 no resettlement. 0 for most resettlement. Other values scaled accordingly
CO2 Emissions	**10%**	Calculated in transport model based upon equations to convert vehicle speeds and distances into emissions. The lower the better	100 for lowest emissions. 0 for highest emissions. Other values scaled accordingly
Total	**100%**	**Theoretical Maximum Score =**	**100 after weightings applied**

Source: JICA Project Team

O.4 Alternative Land Use/Transport Scenarios

O.4.1 Outline

Three alternative land use/transport scenarios are being investigated and compared, in order to identify the preferred scenario.

There are three alternative land use scenarios as set out in Section O.4.2; and, four alternative transport network strategies, as set out in Section O.4.3. Between them, these produce three combinations of land use and transport scenarios, which are summarised in Table O.3.

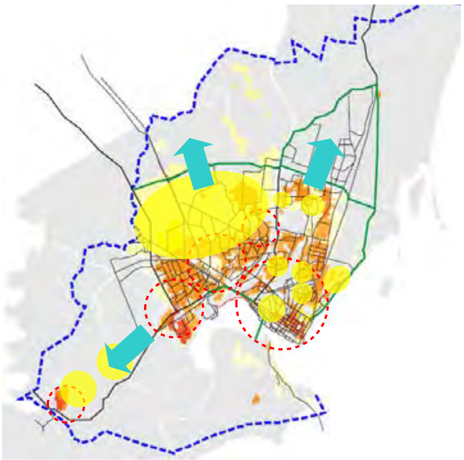
Table O.3: Broad Outline of Alternative Land Use/Transport Scenarios

Option	Land Use Development Pattern	Land Use Characteristics	Transport Network Strategy	Transport Network Characteristics
1	**A: Existing Trend**	Existing trend, Uncontrolled urban sprawl, low density development	**A: Do Nothing**	Only ongoing and committed projects proceed. Automobile oriented. Bus and chapas operate as at present.
2	**B: Poly-Centric Multi Core**	Decentralized development, lower level of concentration at CBD	**B: Bus Rapid Transit**	Automobile and mass transit (BRT, buses and chapas)
3	**C: Compact Corridor**	High density development along mass transit corridors, decentralized population serving industries, higher level of concentration at CBD	**C: BRT and Commuter Rail**	Mass transit (commuter rail, BRT, buses for feeder, or combination of these), relatively lower role for automobiles in urban area

Source: JICA Project Team

O.4.2 Land Use Scenarios

In terms of land-use, Scenario A could be termed "business as usual", based upon an extrapolation of existing trends, such as urban sprawl and the growth of informal settlements in the absence of land use plans and corresponding enforcement of development controls. This is shown in Figure O.3.

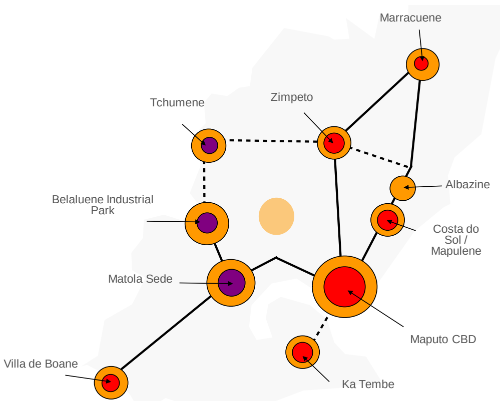


Source: JICA Project Team

Figure O.3: Scenario A Schematic Land Use for 2035

Scenarios B and C represent changes to land use development, coupled with more rigorous development and enforcement of land use plans and zoning.

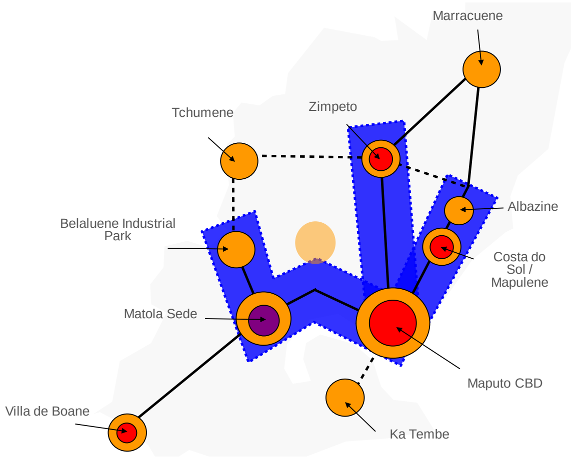
Shown in Figure O.4, Scenario B is predicated upon the development of a poly-centric city. That is to say, the development of secondary CBD's in addition to Maputo City Centre ("Baixa"). This should enable more work-based trips to occur to/from areas other than central Maputo, with the intention of relieving traffic congestion levels and also pressures on property prices in Maputo city centre.



Source: JICA Project Team

Figure O.4: Scenario B Schematic Land Use for 2035

Scenario C develops beyond poly-centres into development intensification in key transit corridors (higher development densities along key bus spines and potential BRT routes, plus development around passenger railway stations). This is shown in Figure O.5. The aim of Scenario C would be to better align property development with transport service provision, particularly public transport networks.



Source: JICA Project Team

Figure O.5: Scenario C Schematic Land Use for 2035

O.4.3 Transport Strategies

For each of these three Scenarios, transport strategies, in the form of transport network characteristics are defined. The transport strategy assumed for Scenario A is the closest of the three to existing practice, but does also include bus priority corridors. Figure O.6 shows a schematic transport network for Scenario A in 2035. The green lines in this Figure represent Bus Priority lanes which will be used to ensure that delays to bus journeys are reduced on key congested routes. By dedicating road space to buses, there will be an impact on car journey times, as road space for cars will reduce. Nevertheless, by removing buses from the car traffic stream, more stable flow might be achievable.

Source: JICA Project Team

Figure O.6: Scenario A Schematic Transport Network for 2035

Scenario B additionally entails the development of Bus Rapid Transit (BRT), as shown in Figure O.7. As can be seen, in this scenario BRT is used instead of priority measures for street-running buses across much of the trunk bus network. This to feed the poly-centres predicated under the respective land use scenario. Moreover, bus and chapa networks are restructured to improve service. Operational efficiency improvements within TPM are also assumed.

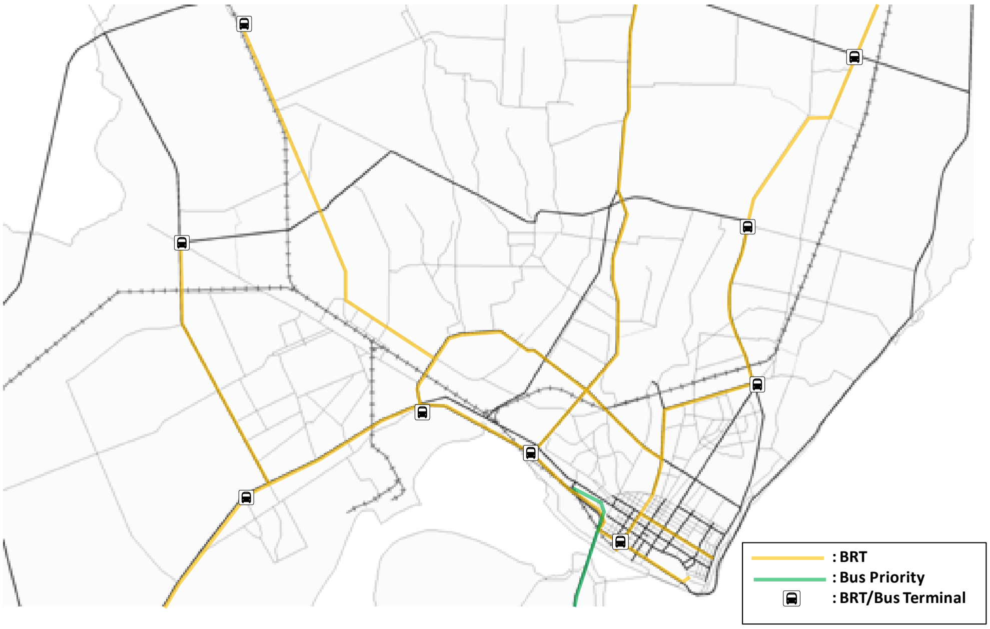


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Figure O.7: Scenario B Schematic Transport Network for 2035

Under Scenario C, depicted in Figure O.8, there is the additional development of commuter railway, requiring the upgrading of existing rail facilities. These rail and BRT corridors to enable Transit-Oriented Development along BRT corridors and around railway stations.

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Figure O.8: Scenario C Schematic Transport Network for 2035

O.5 Evaluation of Alternative Scenarios

O.5.1 Use of Balanced Score Cards

The three scenarios set out in Section O.4 were compared against one another using the multiple criteria set out in Section O.3. However, as it was quite likely that different scenarios would rank differently against different criteria and indeed also different sets of criteria, it was necessary to define a framework to combine scores and rankings to produce clear conclusions.

In addition, it was also necessary to analyse a Do Minimum case, to check that proposed interventions would have a positive impact. This Do Minimum case used Scenario A assumptions for land use, i.e. continuation of current trends; but retained existing transport networks (only incorporating already committed transport improvement projects). The criteria and scoring system, together with the weightings of different factors were set out in Table O.2.

Although the Balanced Score Card methodology should produce a prediction of the preferred scenario, it is likely that the overall preferred scenario would not score highest against all criteria. As such, the Balanced Score Card system can also be used to identify areas for improvement during Pre-Feasibility Studies.

O.5.2 Scoring of Each Scenario

(1) Rankings by Set of Scenario Performance Indicators

Public Transport Mode Share

The scoring for public transport mode share is set out in Table O.4. As can be seen, Scenario C achieves the highest public transport mode share.

Table O.4: Mode Choice by Alternative Scenarios

	Scenario A (Do Minimum)	Scenario B	Scenario C
Person Trips per Day by Car	1,328,416	1,293,314	1,075,089
Person Trips per Day by Public Transport	2,236,750	2,271,924	2,672,502
Public Transport Mode Share	64%	65%	72%
Scenario Ranking	3	2	1

Source: JICA Project Team

Public Transport Passenger Trip Characteristics

Scores and rankings for public transport passenger trip characteristics are shown in Table O.5. As can be seen, Scenario B has the lowest average journey time, with Scenario C ranking second. Scenario A (Do Minimum) achieves the shortest average journey distance. Scenario C achieves the highest average journey speed.

Table O.5: Public Transport Passenger Trip Characteristics by Alternative Scenarios

	Scenario A (Do Minimum)	Scenario B	Scenario C
Trips per Day	2,236,750	2,271,924	2,672,502
Average Journey Times			
Passenger Hours per Day	2,745,617	1,608,472	2,010,770
Average Journey Time (minutes)	45.2	26.5	31.5
Scenario Ranking	3	1	2
Average Journey Distance			
Passenger km per Day	37,177,761	63,251,547	91,315,194
Average Journey Length (km)	10.2	17.3	23.8
Scenario Ranking	1	2	3
Average Journey Speed			
Average Journey Speed (kph)	13.5	39.3	45.4
Scenario Ranking	3	2	1

Source: JICA Project Team

Public Transport Vehicle Operating Characteristics

Scores and rankings for public transport passenger trip characteristics are shown in Table O.6. Scenario B has the lowest number of vehicle hours per day, with Scenario C ranking second. However, Scenario C has both the lowest daily vehicle kilometrage and the highest average vehicle speed.

Table O.6: Public Transport Vehicle Operating Characteristics by Alternative Scenarios

	Scenario A (Do Minimum)	Scenario B	Scenario C
Journey Times			
Vehicle Hours per Day	1,951,453	1,234,555	1,264,464
Scenario Ranking	3	1	2
Journey Distance			
Vehicle km per Day	144,117	33,853	29,466
Scenario Ranking	3	2	1
Average Vehicle Speed			
Average Vehicle Speed (kph)	13.5	36.5	42.9
Scenario Ranking	3	2	1

Source: JICA Project Team

Criteria for Car Users

Scores and rankings for car user criteria are shown in Table O.7. As can be seen, Scenario C achieves the lowest passenger hours, the lowest passenger km and the highest average speeds.

Table O.7: Car User Trip Characteristics by Alternative Scenarios

	Scenario A (Do Minimum)	Scenario B	Scenario C
Journey Times			
Passenger Hours per Day	1,170,861	454,409	336,364
Scenario Ranking	3	2	1
Journey Distance			
Passenger km per Day	19,507,889	18,733,692	15,109,490
Scenario Ranking	3	2	1
Average Journey Speed			
Average Journey Speed (kph)	16.7	41.2	44.9
Scenario Ranking	3	2	1

Source: JICA Project Team

<u>Vehicle Operating Costs</u>

The derivation of VOC from transport model data is described in more detail in Section O.8.2. Table O.8 shows the VOC by scenario; Scenario C achieves the lowest daily VOC.

Table O.8: Vehicle Operating Costs by Alternative Scenarios

MT/day	Scenario A (Do Minimum)	Scenario B	Scenario C
Car	56,884,293	38,870,420	30,346,766
Truck	24,927,140	12,507,527	12,071,905
Bus	42,852,992	11,317,283	6,232,042
BRT	0	14,262,319	23,860,349
Total	124,664,425	76,957,549	72,511,062
Scenario Ranking	3	2	1

Source: JICA Project Team

<u>Resettlement</u>

As stated previously in Section O.3.4, due to a lack of data the appraisal of resettlement was confined to the number of buildings likely to be demolished to accommodate highway components of each scenario. The resultant ranking is shown in Table O.9. As can be seen, Do Minimum ranks highest as it does not require building demolition.

Table O.9: Resettlement Requirements by Alternative Scenarios

	Scenario A (Do Minimum)	Scenario B	Scenario C
Buildings to be Demolished	0	2,110	2,641
Scenario Ranking	1	2	3

Source: JICA Project Team

<u>CO_2 Emissions</u>

The derivation of CO_2 emissions from transport model data is described in more detail in Section O.8.3. Table O.10 shows the carbon emissions by scenario; Scenario C achieves the lowest daily emissions.

Table O.10: Carbon Emissions by Alternative Scenarios

Grams/carbon per day	Scenario A (Do Minimum)	Scenario B	Scenario C
Car	6,157,321	3,916,734	3,041,768
Truck	1,211,407	789,525	770,570
Bus	3,441,994	1,001,961	564,752
BRT	0	624,867	1,060,504
	0	0	0
Total	10,810,722	6,333,086	5,437,594
Scenario Ranking	3	2	1

Source: JICA Project Team

(2) Consolidated Scores and Conclusions

Table O.11 shows values consolidated from the Tables in Section (1). These were then converted into scores as shown in Table O.12; following the application of weightings to these scores, the final ranking of alternatives was as follows:

- Scenario C was identified as the preferred Scenario, with a score of 86;
- Scenario B ranked second, with a score of 69; and,
- Scenario A (Do Nothing) ranked third (and bottom), with a score of 10.

Scenario C is therefore the preferred scenario.

Table O.11: Data Input for Alternative Scenarios

Criterion	Input Values			Score 100 for	Score 0 for
	A	B	C		
Public Transport Mode Share	64%	65%	72%	C	A
Average Public Transport Passenger Journey Times	45.2	26.5	31.5	B	A
Average Public Transport Passenger kilometres	10.2	17.3	23.8	A	C
Average Public Transport Journey Speed	13.5	39.3	45.4	C	A
Total Public Transport Vehicle Hours	1,951,453	1,234,555	1,264,464	B	A
Total Public Transport Vehicle kilometres	144,117	33,853	29,466	C	A
Average Public Transport Vehicle Speed	13.5	36.5	42.9	C	A
Total Car Passenger Hours	1,170,861	454,409	336,364	C	A
Total Car Passenger kilometres	19,507,889	18,733,692	15,109,490	C	A
Average Car Speed	16.7	41.2	44.9	C	A
Vehicle Operating Costs (Car, Truck, Bus, Chapa)	124,664,425	76,957,549	72,511,062	C	A
Resettlement Costs	0	2110	2641	A	C
CO2 Emissions	10,810,722	6,333,086	5,437,594	C	A

Source: JICA Project Team

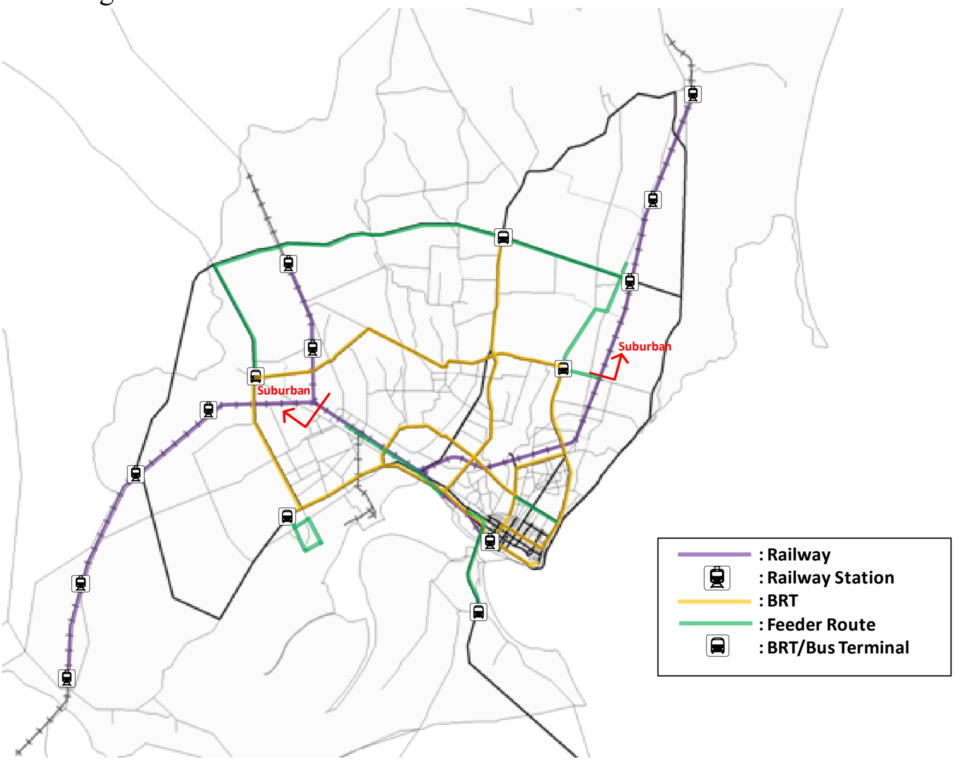
Table O.12: Scoring of Alternative Scenarios

	Unweighted Score (0–100)				Weighted Scores		
Criterion	**A**	**B**	**C**	**Weighting**	**A**	**B**	**C**
Public Transport Mode Share	0	12	100	**15%**	0.0	1.7	15.0
Average Public Transport Passenger Journey Times	0	100	73	**15%**	0.0	15.0	11.0
Average Public Transport Passenger kilometres	100	48	0	**5%**	5.0	2.4	0.0
Average Public Transport Journey Speed	0	81	100	**5%**	0.0	4.0	5.0
Total Public Transport Vehicle Hours	0	100	96	**5%**	0.0	5.0	4.8
Total Public Transport Vehicle kilometres	0	96	100	**5%**	0.0	4.8	5.0
Average Public Transport Vehicle Speed	0	78	100	**5%**	0.0	3.9	5.0
Total Car Passenger Hours	0	86	100	**5%**	0.0	4.3	5.0
Total Car Passenger kilometres	0	18	100	**5%**	0.0	0.9	5.0
Average Car Speed	0	87	100	**5%**	0.0	4.3	5.0
Vehicle Operating Costs	0	91	100	**15%**	0.0	13.7	15.0
Resettlement Costs	100	20	0	**5%**	5.0	1.0	0.0
CO_2 Emissions	0	83	100	**10%**	0.0	8.3	10.0
Total				**100%**	**10**	**69**	**86**
Final Ranking					**3**	**2**	**1**

Source: JICA Project Team

O.6 Transport Network for Master Plan

The preferred transport network, taken into the Master Plan for inter alia economic assessment is as shown in Figure O.9.



Source: JICA Project Team

Figure O.9: Preferred Transport Network

O.7 Economic Analysis Methodology and Evaluation Cases

As stated in Section O.5.2, the preferred scenario carried forward for economic evaluation was land use scenario C and transport network C. This is termed 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 which are summarised in Section O.9.

The outline methodology can be described as follows:

1) Based upon transport model outputs (Section O.10.2) and parameters for economic evaluation (Section O.8), benefit streams are calculated for 2035 and estimated by year
2) Cost streams are also calculated by year (Section O.9)
3) Based upon capital expenditure the proportion of benefits from 1) applying in each year are calculated (Section O.9.7)
4) The resultant cost and benefit streams are then combined (Section O.10.3) in order to perform Discounted Cashflow 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, as set out in Section O.10.4.

O.8 Parameters for Interpretation of Transport Model Outputs

O.8.1 Value of Time INCLUDE BUILD-UP DATA

(1) Broad Approach

The Value of Time (VOT) was estimated based upon:

- 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 the JICA Project Team, per capita GDP in Maputo City and Maputo Province was as shown in Table O.13, 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 O.13: 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. These price inflation estimates are shown in Table O.14.

Table O.14: Price Inflation Estimates

	Year			Compound
	2009	2010	2011	2009–2011
IMF	3.3%	12.7%		
CIA Factbook	3.3%	13.5%	10.4%	
Say	3.3%	13.1%	10.4%	29.0%

Source: IMF, CIA, JICA Project Team

Based on the data in Table O.13 and Table O.14, GDP per capita was then specified in 2012 prices. Furthermore, based upon planning data, 55% of the population in the Study Area lived in Maputo City, with 45% residing in Boane, Matola or Marracuene. And 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, in 2012 prices, as shown in Table O.15.

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, as shown in Table O.16. The resultant VOT's adopted by year, in 2012 prices are shown in Table O.17.

Table O.15: GDP Per Capita in MT in 2012 Prices

	Year			
Location	2012	2018	2025	2035
Maputo City				
Maputo Province				
Boane, Matola, Marracuene				
Study Area as a Whole	61,357	84,267	117,889	161,686

Source: JICA Project Team

Table O.16: Selected Trip Purpose Splits from HIS

Purpose	% of Trips
To Work	22.2
On Business	6.6
From Work *	22.2
All work/ business related	51.0
Non-work/business related	49.0

Source: JICA Project Team
Note: * From work taken to be the same as To Work

Table O.17: 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

O.8.2 Vehicle Operating Costs

(1) Data Sources

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.

Data on individual cost elements were however collected locally by the JICA Project Team.

(2) Outline Approach

The approach is summarised 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) – see Section (3)
- 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) – see Sections (4) and (5)
- Input costs of tyres and oil and estimation of cost per km – see Section (6)
- Depreciation costs – see Section (7)
- 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) – see Section (6)

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. Final VOC's are presented in Section (9).

(3) Basic Data on Vehicles

Table O.18 presents the basic data collected on various vehicle types. Note that these are economic costs, excluding and taxes on vehicle purchase. The difference between "Car (2012)" and "Car (2035)" is attributable to the shift towards smaller vehicles, irrespective of whether Do Minimum or Do Maximum is being tested. However, "Bus (now)" relates to current operating practices at TPM, whilst "Bus (future)" relates to revised operating practices as part of the "Do Maximum" scheme. Prices of buses and BRT vehicles were advised by the appropriate experts in the JICA Project Team.

(4) Initial Fuel Consumption Data

Initial fuel consumption rates, in litres per km according to speed and vehicle type, were taken from the UK DfT WebTAG. Fuel consumption equations take the form:

$$Litres\ per\ km = A + B.V + C.V^2 + D.V^3$$

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

Table O.19 shows the parameter values A, B, C and D for fuel consumption by vehicle type, as well as the litres of fuel consumed per km according to speed. Based upon a local petrol price of MT 47.52 per litre and a local derv price of MT 36.31 per litre, Table O.20 shows similar parameters but denominated in MT.

(5) Adjustments for Roughness

The values derived in Section (4) are based upon UK road conditions, where roads are typically paved and relatively smooth. In contrast, many of the roads in Maputo are unpaved and/or in poor condition. This roughness was taken into account. Table O.21 shows how costs in HDM vary by roughness, based upon the International Roughness Index (IRI).

Taking account of the surveyed vehicle mixes, Table O.22 shows the adjustment factors calculated for VOC according to different roughness levels. It was assumed that overall IRI in 2012 (Do Minimum) was 8.0, to take account of road conditions and the extent of unpaved roads. For Do Maximum, IRI was assumed to be 4.0. Table O.23 shows the revised fuel costs per km by vehicle type and speed for IRI=4.0 and IRI=8.0.

Table O.18: Basic Data on Vehicles

	Car (2012)	Car (2035)	Bus (now)	Bus (future)*	Minibus	LGV	MGV/HGV	BRT
Average km/year	23,000	23,000	30,625 **	75,000	27,500	45,000	51,000	75,000
Life (years)	10	10	6**	10	10	10	10	10
Economic Purchase Cost/ vehicle (MT)	59,540	59,100	2,607,750	4,346,250	384,750	541,243	2,279,363	7,635,000
Cost per Tyre (MT)	2,300	2,300	2,400	2,400	2,400	2,100	2,400	2,400
Number of Tyres	4	4	6	6	6	6	8	8

Source: JICA Project Team

Notes: * Bus (future) assumed adoption of bus reorganization and other improvements. For Do Minimum, costs from Bus (now) apply in future years

** Average km/year and lifetime for Bus (now) estimated based on operations analysis – see Section (6)

Table O.19: Fuel Consumption by Vehicle Type and Speed (before Accounting for Roughness)

	Fuel Consumption Parameters				Litres of Fuel by Speed (kph)									
Vehicle Type	a	b	c	d	0	10	20	30	40	50	60	70	80	90
Car (2012)	0.18805	−0.0043795	0.0000507	−0.00000017	0.188	0.149	0.119	0.098	0.083	0.075	0.071	0.072	0.075	0.081
Car (2035)	0.17814	−0.0040587	0.0000461	−0.00000015	0.178	0.142	0.114	0.094	0.080	0.072	0.068	0.069	0.072	0.078
Pick-Up/ Van	0.19629	−0.0030089	0.0000166	−0.00000006	0.196	0.168	0.142	0.119	0.099	0.080	0.063	0.047	0.032	0.017
Minibus	0.16362	−0.0027664	0.0000202	−0.00000008	0.164	0.138	0.116	0.097	0.080	0.066	0.054	0.043	0.033	0.023
Bus	0.63467	−0.0189897	0.0002743	−0.00000122	0.635	0.471	0.355	0.279	0.236	0.219	0.220	0.232	0.248	0.261
LGV	0.76834	−0.0225730	0.0003177	−0.00000135	0.768	0.573	0.433	0.340	0.287	0.265	0.265	0.280	0.302	0.322
MGV/HGV	1.02443	−0.0302181	0.0004429	−0.00000201	1.024	0.765	0.581	0.462	0.396	0.370	0.372	0.391	0.414	0.430
BRT	0.95200	−0.0284846	0.0004115	−0.00000182	0.952	0.706	0.532	0.419	0.354	0.328	0.330	0.349	0.373	0.391

Source: JICA Project Team, UK DfT WebTAG

Table O.20: Fuel Costs per km by Vehicle Type and Speed (before Accounting for Roughness)

Vehicle Type	Fuel Cost Parameters (MT)				Cost of Fuel (MT) by Speed (kph)									
	a	b	c	d	0	10	20	30	40	50	60	70	80	90
Car (2012)	8.936024	−0.208112	0.002408	−0.00000804	8.936	7.088	5.673	4.643	3.951	3.547	3.384	3.413	8.936	8.936
Car (2035)	8.465190	−0.192871	0.002189	−0.00000704	8.465	6.748	5.427	4.459	3.802	3.414	3.252	3.275	8.465	8.465
Pick-Up/Van	5.941080	−0.100446	0.000733	−0.00000275	5.941	5.007	4.203	3.513	2.920	2.408	1.960	1.559	5.941	5.941
Minibus	23.044819	−0.689516	0.009960	−0.00004416	23.045	17.102	12.885	10.131	8.574	7.950	7.993	8.438	23.045	23.045
Bus	23.044819	−0.689516	0.009960	−0.00004416	23.045	17.102	12.885	10.131	8.574	7.950	7.993	8.438	23.045	23.045
LGV	27.898335	−0.819627	0.011534	−0.00004918	27.898	20.806	15.726	12.363	10.421	9.605	9.621	10.174	27.898	27.898
MGV/HGV	37.197110	−1.097220	0.016080	−0.00007283	37.197	27.760	21.102	16.786	14.375	13.432	13.519	14.201	37.197	37.197
BRT	31.512178	−0.927510	0.013301	−0.00005837	31.512	23.509	17.815	14.082	11.957	11.092	11.136	11.739	31.512	31.512

Source: JICA Project Team, UK DfT WebTAG

Table O.21: Sample Costs per Vehicle-km from HDM-IV with Respect to Vehicle Type and Roughness

Roughness (IRI, m/km)	Vehicle Type											
	Motor-cycle	Small Car	Medium Car	Delivery Vehicle	Four-Wheel Drive	Light Truck	Medium Truck	Heavy Truck	Articulated Truck	Small Bus	Medium Bus	Large Bus
2.0	0.090	0.154	0.210	0.224	0.228	0.246	0.418	0.698	1.008	0.271	0.576	0.790
4.0	0.091	0.157	0.214	0.229	0.235	0.255	0.436	0.738	1.061	0.278	0.602	0.823
6.0	0.092	0.159	0.220	0.239	0.248	0.270	0.466	0.801	1.122	0.292	0.660	0.893
8.0	0.092	0.166	0.232	0.254	0.267	0.286	0.497	0.852	1.201	0.314	0.738	1.007
10.0	0.094	0.178	0.250	0.277	0.292	0.307	0.535	0.921	1.312	0.346	0.834	1.158

Source: HDM-IV

Table O.22: Adjustment Factors for Different Roughness Levels

Roughness (IRI, m/km)	Vehicle Type: Car	Minibus	Bus/BRT	Goods Vehicles
2.0	1.000	1.000	1.000	1.000
4.0	1.014	1.024	1.045	1.040
8.0	1.073	1.160	1.281	1.173
10.0	1.152	1.277	1.448	1.266

Source: JICA Project Team, HDM-IV

Table O.23: Fuel Costs (MT per km) by Vehicle Type and Speed, by Roughness

Vehicle Type	Parameters for IRI = 4				Parameters for IRI = 8			
	a	b	c	d	a	b	c	d
Car (2012)	9.0649	−0.2111	0.0024	−8.15E−06	9.5885	−0.2233	0.0026	−8.62E−06
Car (2035)	8.5873	−0.1957	0.0022	−7.14E−06	9.0833	−0.2070	0.0023	−7.55E−06
Pick-Up/Van	6.0840	−0.1029	0.0008	−2.82E−06	6.8892	−0.1165	0.0009	−3.19E−06
Minibus	24.0902	−0.7208	0.0104	−4.62E−05	29.5111	−0.8830	0.0128	−5.65E−05
Bus	24.0902	−0.7208	0.0104	−4.62E−05	29.5111	−0.8830	0.0128	−5.65E−05
LGV	29.0143	−0.8524	0.0120	−5.11E−05	32.7247	−0.9614	0.0135	−5.77E−05
MGV/HGV	38.6850	−1.1411	0.0167	−7.57E−05	43.6322	−1.2870	0.0189	−8.54E−05
Overall Goods Vehicle	32.7727	−0.9646	0.0138	−6.07E−05	36.9638	−1.0880	0.0156	−6.85E−05
BRT	36.1354	−1.0812	0.0156	−6.92E−05	44.2666	−1.3245	0.0191	−8.48E−05

Source: JICA Project Team, UK DfT WebTAG

(6) Tyre and Oil Costs

Both tyre and oil costs are incurred on a per-km basis. However, both tyre and oil costs were also adjusted according to roughness. Table O.24 shows tyre costs per km by vehicle type. Table O.25 shows oil costs per km by vehicle type.

Table O.24: Tyre Costs (MT/km) by Vehicle Type and Roughness

	Base Costs per km	IRI=4.0	IRI=8.0
Car (2012)	0.2000	0.2029	0.2146
Car (2035)	0.2000	0.2029	0.2146
Pick-Up/ Van	0.1477	0.1512	0.1713
Minibus	0.3000	0.3136	0.3842
Bus	0.3000	0.3136	0.3842
LGV	0.3323	0.3456	0.3898
MGV/HGV	0.5000	0.5200	0.5865
Overall Goods Vehicle	0.3975	0.4134	0.4662
BRT	0.5000	0.5227	0.6403

Source: JICA Project Team

Table O.25: Oil Costs (MT/km) by Vehicle Type and Roughness

	Base Costs per km	IRI=4.0	IRI=8.0
Car (2012)	0.1913	0.1941	0.2053
Car (2035)	0.1913	0.1941	0.2053
Pick-Up/ Van	0.2400	0.2458	0.2783
Minibus	0.1760	0.1840	0.2254
Bus	0.1760	0.1840	0.2254
LGV	0.1956	0.2034	0.2294
MGV/HGV	0.2588	0.2692	0.3036
Overall Goods Vehicle	0.2201	0.2289	0.2582
BRT	0.2640	0.2760	0.3381

Source: JICA Project Team

(7) Depreciation Costs

Depreciation was calculated based upon vehicle purchase cost, lifetime and interest rates. Depreciation parameters are specified as follows:

$$Depreciation\ per\ km = A + E/V$$

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

As it is reasonable to assume that worse road conditions would add to wear-and-tear on vehicles and hence shorten vehicle lifespan, thus increasing the depreciation rate, roughness was also taken into account when determining depreciation costs. Table O.26 shows the resultant depreciation cost parameters.

Table O.26: Depreciation Cost Parameters by Vehicle Type and Roughness

	Base Costs per km		IRI=4.0		IRI=8.0	
Vehicle Type	**a**	**e**	**a**	**e**	**a**	**e**
Car (2012)	0.2589	0.0000	0.2626	0.0000	0.2778	0.0000
Car (2035)	0.2570	0.0000	0.2607	0.0000	0.2757	0.0000
Pick-Up/ Van	1.1659	21.8356	1.1940	22.3610	1.3520	25.3201
Minibus	7.0959	177.5961	7.4178	185.6527	9.0870	227.4288
Bus	2.8975	102.5623	3.0289	107.2150	3.7105	131.3409
LGV	0.6014	19.1583	0.6254	19.9246	0.7054	22.4727
MGV/HGV	2.2347	80.6822	2.3241	83.9095	2.6213	94.6402
Overall Goods Vehicle	1.2361	43.0687	1.2856	44.7915	1.4500	50.5196
BRT	5.0833	179.9339	5.3139	188.0965	6.5097	230.4226

Source: JICA Project Team

(8) Crew Costs and Overheads for Commercial Vehicles

Crew costs and overheads were calculated in two parts: one part related to annual kilometrages ("a" parameter) and the other was inversely proportional to speed ("e" parameter). No roughness adjustment was applied to these costs. The assumed costs are shown in Table O.27. Note that these costs do not apply to private cars.

Table O.27: Crew and Overhead Cost Parameters by Vehicle Type

	Base Costs per km	
Vehicle Type	**a**	**e**
Car (2012/2035)	0.0000	0.0000
Pick-Up/ Van	0.6764	178.5600
Minibus	8.5029	634.8800
Bus	5.1017	264.5333
LGV	1.2400	167.4000
MGV/HGV	1.8235	217.0000
Overall Goods Vehicle	1.4844	186.6764
BRT	6.0937	132.2667

Source: JICA Project Team

(9) Final VOC's

Final VOC's were defined based upon the combination of cost elements outlined in previous sub-sections. 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 O.28; whereas Table O.29 shows Do Maximum VOC's, which assume IRI=4.

Table O.28: 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 O.29: 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 O.8.4). In passenger-km terms, bus VOC would be lower in Do Maximum than Do Minimum.

O.8.3 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, Transport and Communication 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 O.30.

Table O.30: 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 monetised 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).

O.8.4 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.

O.8.5 Annualisation 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.

O.9 Project Cost Data

O.9.1 Introduction

Not all costs shown in the Financial Analysis (Technical Report H) 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

O.9.2 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 O.31.

O.9.3 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 O.32.

O.9.4 Cost Streams and Residuals for Rail

Cost streams included for rail comprise:

- Vehicle investment
- Station investment
- Station rehabilitation

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

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 O.33.

O.9.5 Cost Streams and Residuals for Road Projects

A number of road projects are envisaged. Their construction cost schedules, along with residual costs are shown in Table O.34 (a 40-year lifetime is assumed in each case). Table O.35 shows cost schedules for rehabilitation and maintenance.

O.9.6 Cost Streams and Residuals for Traffic Management

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 O.36.

Table O.31: Project Components, Cost Streams and Residuals for TPM/ Conventional Bus (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
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 O.32: Project Components, Cost Streams and Residuals for Bus Rapid Transit (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
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 O.33: Project Components, Cost Streams and Residuals for Rail (MT Million per Year)

Component	Life (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
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 O.34: 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 O.35: 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 O.36: 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

O.9.7 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 realised, as projects do not get implemented until later. In order to estimate the approximate proportion of benefits which may be realised 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 realised in year *y+1*. These calculations are shown in Table O.37

Table O.37: 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

O.10 Economic Evaluation Results

O.10.1 Introduction

This Section described the economic evaluation calculations and results. It is structured as follows:

- Sub-Section O.10.2 describes transport model outputs and the monetisation of these outputs in 2012 and 2035 for both Do Minimum and Do Maximum cases
- Sub-Section O.10.3 sets out the resultant benefit streams by year, taking into account the factors presented in Table O.37 (i.e. Do Minimum costs minus Do Maximum costs), combined with cost streams described in Section O.9 into net benefit streams
- Sub-Section O.10.4 presents the economic evaluation statistics, namely NPV, EIRR and Payback Period.

O.10.2 Transport Model Outputs

Technical Report N sets out the full range of metrics generated from the transport model runs. However, Table O.38 presents key metrics used in economic analysis, including VOC and VOT as calculated from the transport model outputs.

Table O.38: 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**
CO2 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

O.10.3 Benefit Streams

The figures shown in Table O.38 are used to interpolate benefits from 2013 to 2035. Applying the factors in Table O.37 (to account for the proportion of Do Maximum rolled-out by year) then gives estimated benefit streams (monetised VOC, passenger time savings and differences in emissions). These are then annualised using a factor of 330 (as described in Sub-Section O.8.5).

Combining these with cost data (from Section O.9) enables the generation of net benefit streams, as shown in Table O.39.

Table O.39: 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

O.10.4 Economic Evaluation Results

Based upon the data in Table O.39, 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

Technical Report P

Transit-Oriented Development (TOD): The Japanese Experience

Contents

Figures

Tables

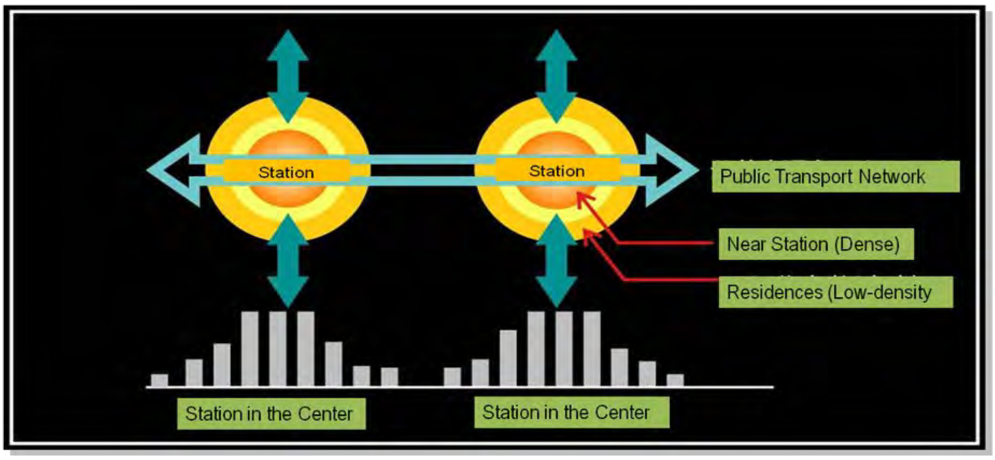
Technical Report P Transit-Oriented Development (TOD): The Japanese Experience

P.1 Transit-Oriented Development and the Compact City

Transit-Oriented Development (TOD) refers to development surrounding transit stations for various functions such as residential, commercial, business, public amenities, and open space. Such development is usually within a 10-minute walk radius from the station.

There are two types of development depending on the location. Urban TOD is usually developed with public transport networks with LRT, HRT, and BRT stations at its core, and have high-density commercial complexes and offices, and mid- to high-density residential development around the station. On the other hand, TOD in suburban areas has commercial facilities at its core, and is located along a feeder bus route with about a 10-minute ride (5 km) to access main public transport. It has medium-dense residences, service facilities, shops, public offices, and the like.

The concept of the "Compact City" in Japan (see Figure P.1) started from lessons learned from uncontrolled sprawl of residential areas in the suburbs of major cities in the past. The concept seeks to guide the development of a city that is as compact as possible from various points of view. TOD is one of the typical strategies applied to plan a city.



Source: Nikken Sekkei Research Institute

Figure P.1: Compact City Development Concept: Station as the Center

There are two major benefits of TOD. First, it creates a more pedestrian-friendly environment. As seen in the example of Strasburg (described in Figure P.2), introducing public transport can reduce road traffic and create a more efficient use of road space, which then provide a more comfortable and safe walking environment.

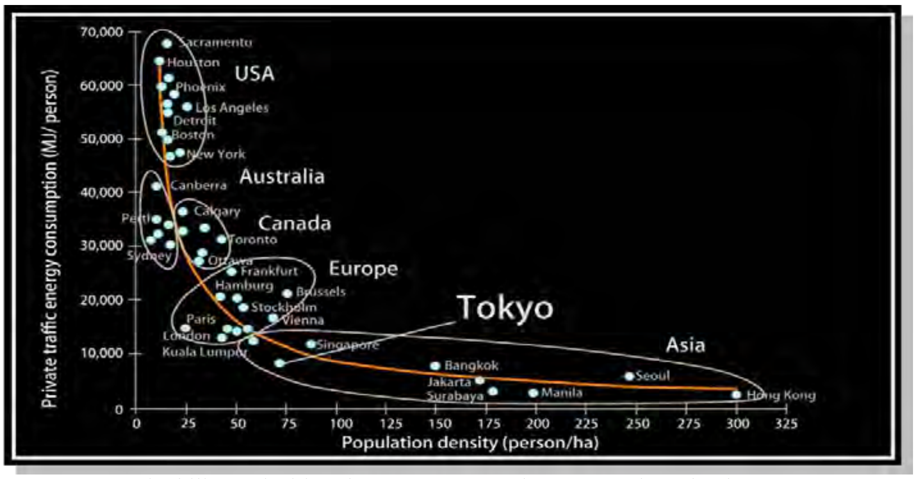
Homme de Fer Station

Langstross-Grand'Rue Station

Source: Guidance on Implementation of Comprehensive LRT Implementation [in Japanese], Japan Ministry of Land, Infrastructure, Transport and Tourism

Figure P.2: Before/After Introduction of Public Transport in Strasburg in France

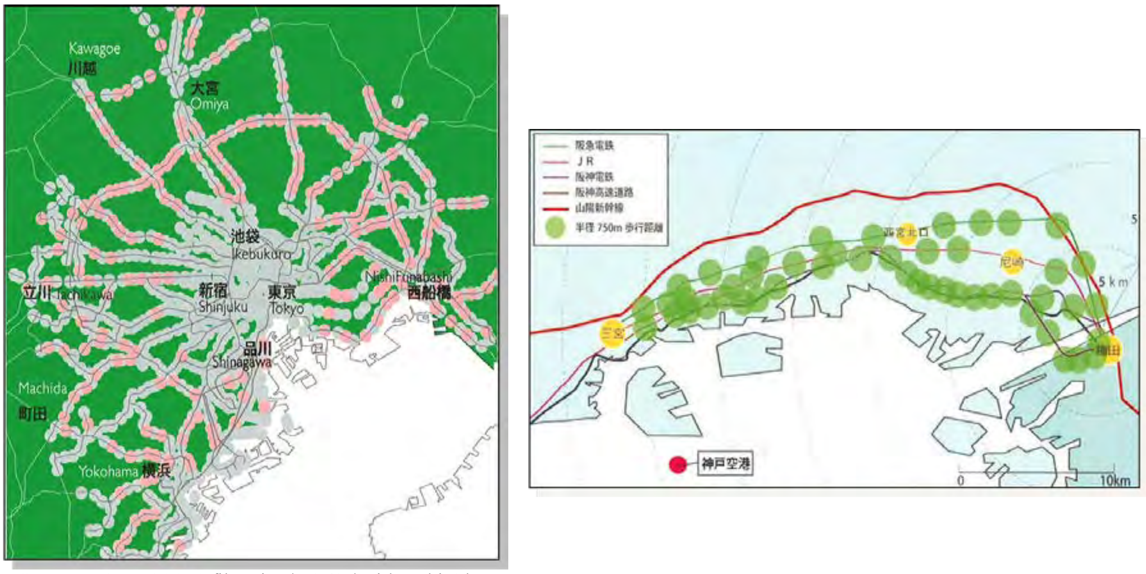
Second, the compact city and TOD contribute to creating a "low-carbon" society. The compact layout of offices and residences allows people to access facilities easily, making people less dependent on automobiles. Figure P.3 illustrates the relationship between urban population density and gasoline consumption per capita.



Source: "Sustainability and Cities" by P. Newman and J. Kenworthy, Island Press, 1999

Figure P.3: Relationship between Urban Population Density and Gasoline Consumption Per Capita

Japanese TOD is usually centered around railway stations. Figure P.4 shows residential development along railway lines in the Tokyo area and Osaka–Kobe metropolitan areas. Green circles represent the areas within a ten-minute walk (about a 800 m radius) of the stations. Major cities in Japan are a conglomerate of compact cities formed with a station in the center.



Source: TOKYO2050 fibercity / JA63 / Hidetoshi Ohno

Figure P.4: Continuous Circles Showing Walking Distance along Railway Lines in Tokyo (Left) and Osaka–Kobe (Right)

P.2 Key Principles of TOD in Japan

P.2.1 City Scale is Set by Walking Distance

Spacing between stations is set as twice walking distance, the length of which is usually about 750–800 m. A living environment conducive to the use of transit is established through the planning of areas within walking distance of the station. Figure P.5 shows distances between stations along the Tokyo Den-en-Toshi Line in Tokyo.

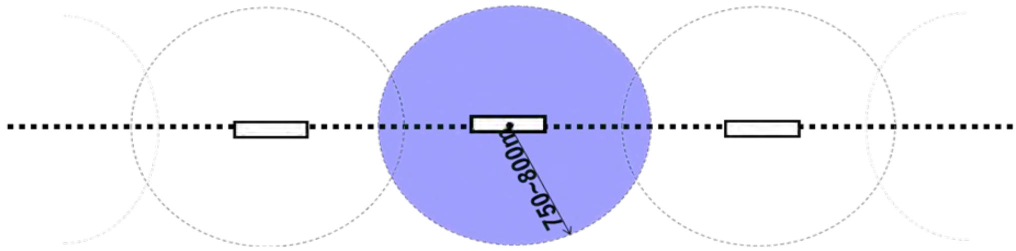


Figure P.5: Distance between Stations along Tokyu Den-en-Toshi Line

P.2.2 Densities around Stations

Densities around stations range from high density in areas closest to the station, to lower density in the areas further away from the station. This creates a compact city by efficiently laying out mixed use functions. Figure P.6 demonstrates the concept.

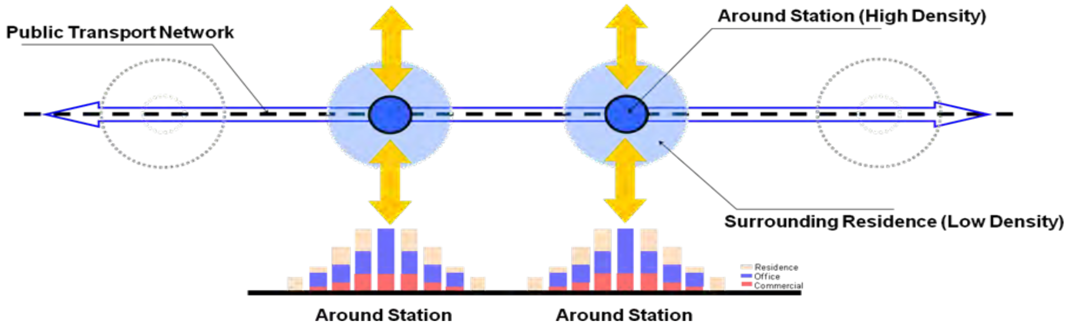


Figure P.6: Densities around Stations

P.2.3 Efficient Train Operation and Demand Generation

The development of facilities at terminal stations as well as stations along the line can create passenger flow. The movement of people to commercial facilities (e.g., shopping malls, universities, leisure facilities) can increase revenues from train operations. Figure P.7 illustrates the generation of demand along a railway.

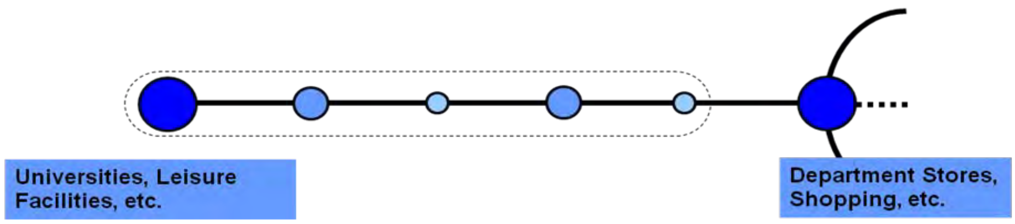


Figure P.7: Generation of Demand along a Railway

P.2.4 Expand Development Area with Use of Bus Network

Establishing a bus network taking into consideration the future expansion of development areas can improve the convenience of people living beyond walking distance of the station. Figure P.8 illustrates this concept.

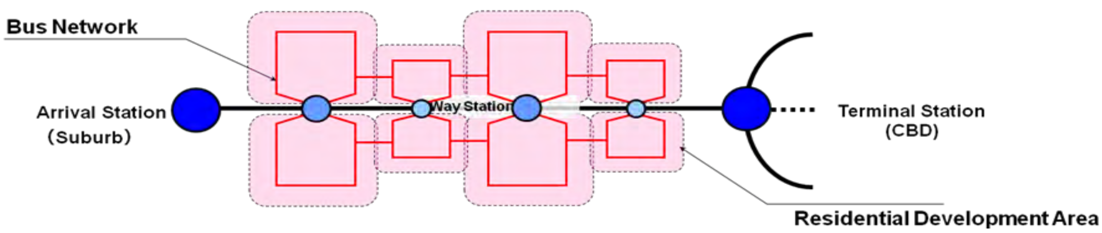


Figure P.8: Reach of the Bus Network

P.2.5 Comprehensive Development of the Station and Town

Locating a TOD Center to allow for easy transfer between modes by integrating the development of a railway station, bus station/stops, and other buildings can efficiently use space, creating a more compact layout of facilities. Figure P.9 illustrates the integrated development of modes.

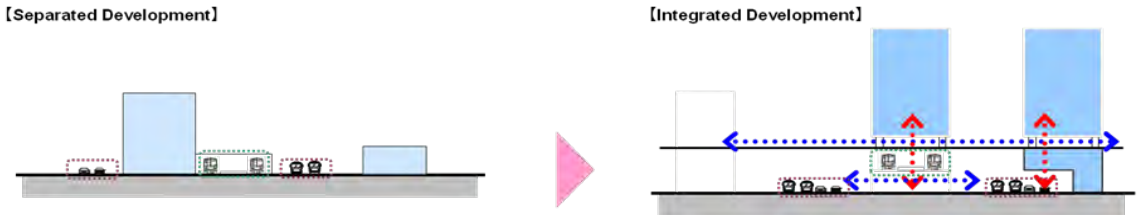


Figure P.9: Integrated Development of Modes

P.2.6 Improved Business Feasibility

Business feasibility can be improved by absorbing profits from residential land development through integrated development of residential land and railway facilities. Figure P.10 illustrates the concept.

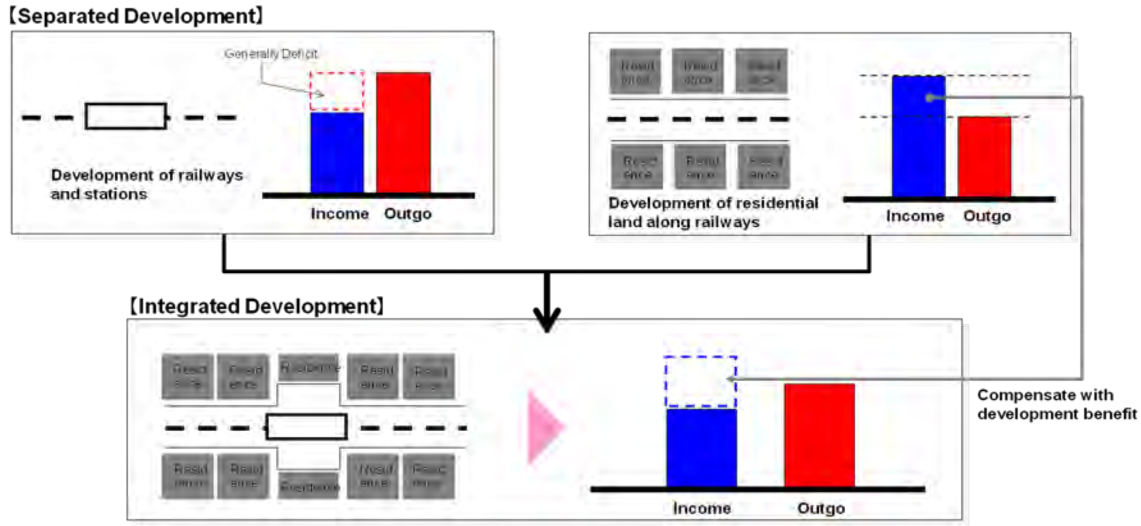


Figure P.10: Business Feasibility of Integrated Development

P.3 Railway Development in Japan

There are three patterns of railway development in Japan: (i) development mainly by the public sector, (ii) development by the private sector, and (iii) development by public and the third sector.[1] Table P.1 shows that the Tokyu Den-en-Toshi-Line is a “Private + Private” model, and the Tsukuba Express Line is a “Quasi-public + Public” model. This section introduces the Tokyu Den-en-Toshi Line, in which case the private sector developed both the railway and land, as well as the Tsukuba Express, in which a quasi-public sector entity developed the land along the railway.

[1] The third sector refers to a corporation jointly established by the public sector and private sector.

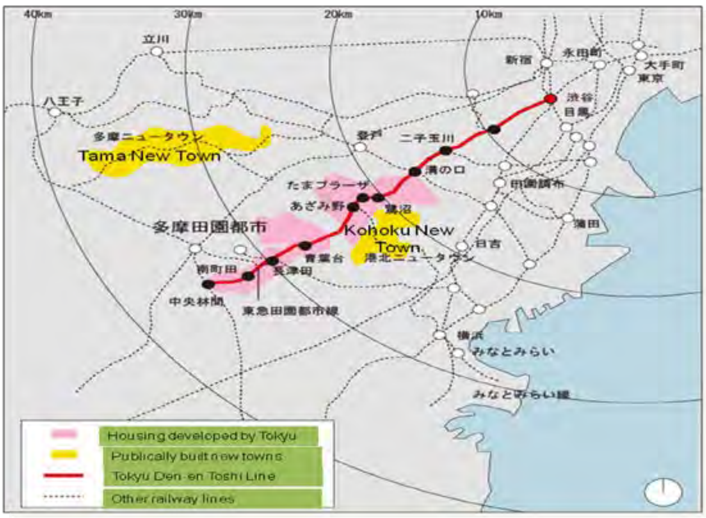
Table P.1: Examples of Different Types of Railway/Land Development

		Railway Development		
		Private	**Quasi-Public**	**Public**
Land Development	Private	■**Private Tokyu Corporation (Den-en-Toshi Line) + Private Tokyu Corporation (Tama Den-en City)** ■**Private** Hankyu Railway (Takarazuka Line) + **Private** Hankyu Railway (Ikeda Muromachi Housing Area)		
	Public	■**Private** Odakyu Electric Railway Co (Odakyu Tama Line)/Keio Corporation (Keio Sagamihara Line) + **Public** Yokohama City/ Urban Renewal Agency (Tama New Town)	■**Private** Keisei Electric Railway (Hokuso Line) + **Public** UR Agency (Chiba New Town) ■**Third Sector** Metropolitan Intercity Railway Company (Tsukuba Express) + **Public** Urban Renewal Agency (e.g., Nakane/Kondadai)	■**Public** Yokohama City (Municipal Subway) + **Public** Yokoyama City/ Urban Renewal Agency (Kohoku New Town)

Source: JICA Project Team

The Tama Den-en-Toshi Line was developed through an expansion of the integrated land and railway business model during the new town construction period. It is an example of strategic development of housing along a railway line.

The development of Tama New Town and Kohoku New Town was led by the public sector, while development of the railway was by the private sector in the former case and by the public sector in the latter case. Measures were put in place to allow for a public-led integrated business (for land and railway development). The Tsukuba Express was constructed by the third sector. Figure P.11 presents a map of developments along the Tokyu Den-en-Toshi Line.



Source: Nikken Sekkei Research Institute

Figure P.11: Developments along the Tokyu Den-en-Toshi Line

P.4 Tama Den-en-Toshi Line

P.4.1 Overview

The Tokyu Den-en Toshi Line supports the mass movement of people living in Tama Den-en-Toshi City. It runs 31.5 km from Shibuya Station in the city center to Chuo-Rinkan Station, and is a privately developed line. From the beginning there were plans to eventually connect this line with the Tokyo Metro's Hanzomon Line, thereby providing a convenient direct connection for users.

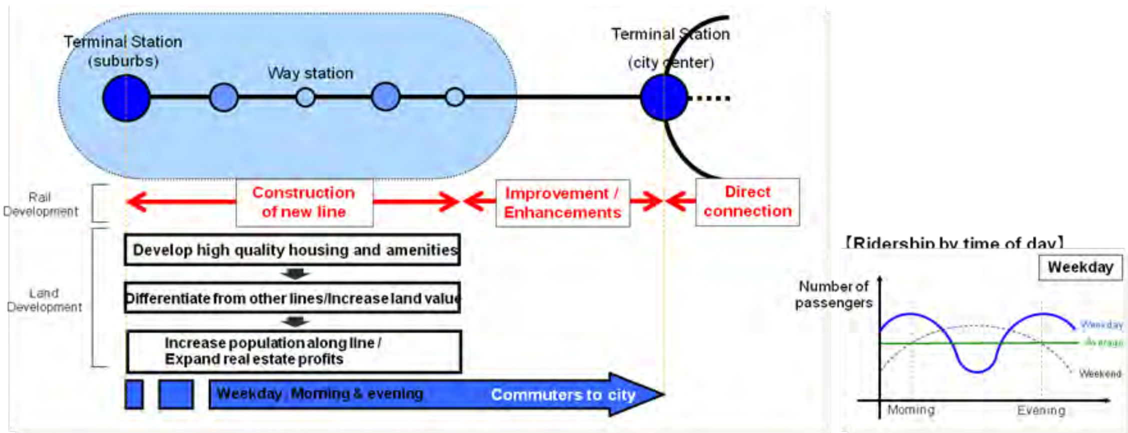
P.4.2 Land Readjustment Measures and Packaged Representation

One of the main features of the Den-en-Toshi Line was the use of land readjustment measures in the development process. Such measures were implemented because the acquisition of land was difficult, and there was also a need to control acquisition costs.

Adoption of the packaged representation method allowed Tokyu to act as the representative of the landowners, serve as a cooperative member to reorganize land plots, and also act as a railway company. This method was adopted because it improves the convenience of the living environment for landowners with good railway access, and the improved infrastructure access increases the value of their land without their having to finance it themselves.

P.4.3 Simultaneous Development of Railway and Land along a Railway

There are two features of the business model for the development of Tama Den-en-Toshi Line. First is the development method of simultaneously developing the railway and land. Developing both at the same time allows for profits from real estate (mainly from home sales along the railway) and ensures ridership on the railway, which provides stable revenue and profit. Figure P.12 illustrates the combination of railway and land development.

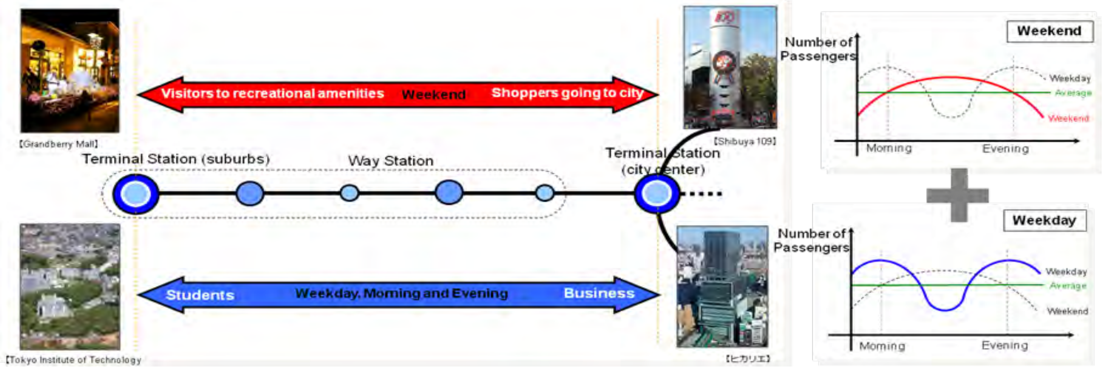


Source: Nikken Sekkei Research Institute

Figure P.12: Combination of Railway and Land Development

P.4.4 Development of Hubs and Establishment of the Tokyu Brand

The second feature of the business model is the planned provision of high-quality facilities at the hubs along the line, in the suburbs, at stations along the way, and in the city center. Tokyu established its brand through the development of its hubs, raising the value of the line and real estate, which then increased their development profits. Figure P.13 illustrates the concept.



Source: Nikken Sekkei Research Institute and photographs from the websites of the respective facilities

Figure P.13: Development of Hubs along the Railway Line and Establishment of the Tokyu Brand

In addition, to increase railway efficiency and create demand for travel in the reverse direction, Tokyu attracted universities and private schools, large-scale recreational facilities, and other developments. This ensures stable ridership on both weekdays and weekends.

P.4.5 Other Characteristics of Private Development

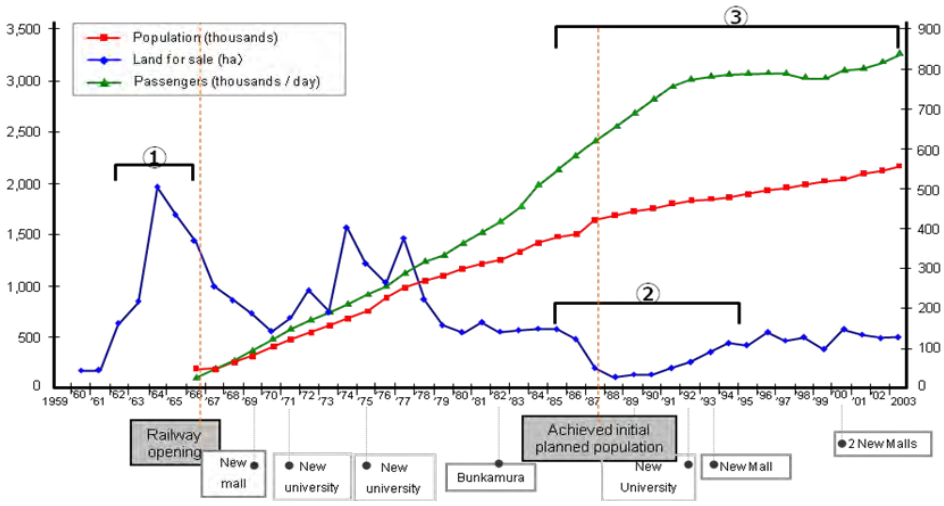
Other characteristics of development of the Tokyu Den-en-Toshi Line, by development phase, follow:

Phase 1: Large-scale purchase of land in the initial development stage established the population and funds necessary to sustain the line.

Phase 2: To increase the brand value of its towns, after having achieved the initial target population, Tokyu implemented various measures such as limiting the housing available for sale to increase land values.

Phase 3: Tokyu further increased ridership through the development of surrounding areas.

Figure P.14 illustrates of development of the Tokyu Den-en-Toshi Line.

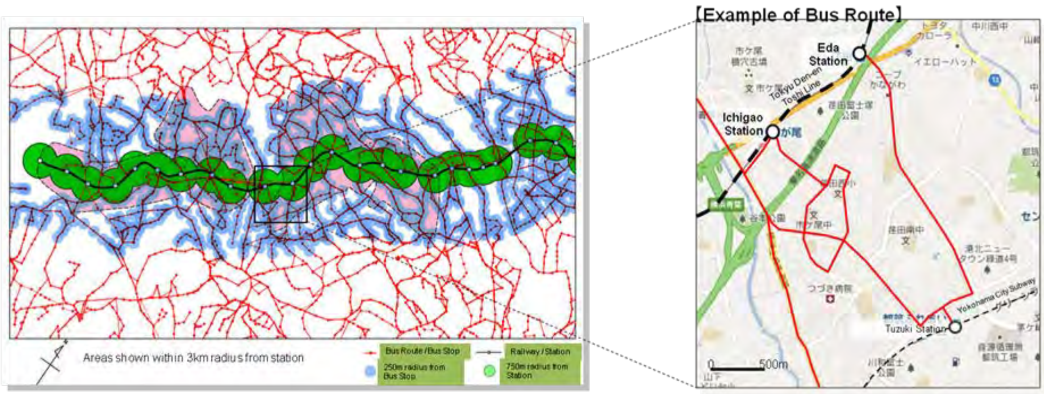


Source: Nikken Sekkei Research Institute

Figure P.14: The Three Phases of Development of the Tokyu Den-en Toshi Line

P.4.6 Expansion of Reach through the Bus Network

The distance between stations on the Tokyu Den-en Toshi Line is such that the line creates a string of small towns within walking distance of a station, as seen in Figure P.15. (Green circles in the figure show a 750 m radius from a station, while blue circles show a 250 m radius from a bus stop.) Bus operations that extend further support the city of Tama Den-en-Toshi. By reaching areas beyond walkable distances from the station, the bus network provides convenient transport access to residential developments, thereby allowing for continued development in these areas.



Source: Nikken Sekkei Research Institute

Figure P.15: Walkable Distances from Railway Stations and Bus Stops

P.5 Tsukuba Express

P.5.1 Overview

The Tsukuba Express (TX) starts in Akihabara in Tokyo and runs through Saitama and Chiba Prefectures to reach Tsukuba City in Ibraraki Prefecture. It is a high-speed city railway that extends 58.3 km. The main objectives of the development of the Tsukuba Express were to: (i) develop a transportation system linking the area northeast of the capital, (ii) ease the burden on the existing Japan Railways (JR) Joban Line, (iii) add to the supply of quality housing in the metropolitan area, and (iv) develop industrial infrastructure along the line and create functional urban hubs in outer areas.

This line was developed by the third sector through application of the Law on Special Measures for Promotion of Housing and Railway Development in Urban Areas (1989). Development of the Tsukuba Express established new suburban communities and also created a network of connected cities with considerable interaction and cooperation between and among them. Originally, the Tsukuba Express was to be part of a planned rehabilitation of the Joban Line of the former Japanese National Railways (JNR), but after JNR was privatized in 1987 and transferred to JR Group companies, the procurement of funds and risk management presented challenges. To address these challenges, the third sector method was adopted with participation of local governments.

P.5.2 Development by the Third Sector

In March 1991, a third sector Metropolitan Intercity Railway Company was established and development began with funds from Tokyo, Saitama, Chiba, and Ibaraki Prefectures as well as from municipalities along the line. Table P.2 presents a breakdown of the funds. Construction was mainly done by the Japan Railway Construction Public Corporation, with construction costs of about USD 10 billion equivalent.

Table P.2: Financial Arrangements of the Tsukuba Express

Main	Percentage	Financing method
Japan Railway Construction, Transport and Technology Agency (Incl. subsidy)	40%	Loan without interest
Local governments (Tokyo, Saitama, Chiba, Ibaraki, etc.)	40%	Loan without interest
	14%	Investment
Government Loan, etc	6%	Loan
Total	100%	-

P.5.3 Implementation through Special Measures for Housing and Railway Development

The Tsukuba Express was developed applying the Special Measures on Housing and Railway law. The specific challenges addressed included the following;

- the long period of time required for negotiations for land acquisition;
- the possibility of severe delays in the construction schedule if there is a landowner opposing the development;
- disorganized and incoherent development around the station and along the railway line; and
- the tendency to leave farmland untouched for long periods of time with the hope of future land value increases.

The objective of this law is to provide for stable development of railway and housing, and improve the living environment of persons living in metropolitan areas, as well as to contribute to the orderly development of the area. The law requires prefectures and stakeholders to establish a committee to thoroughly discuss city planning and railway development. In addition, to make land acquisition easier, integrated land readjustment measures have been implemented, allowing for the consolidation of purchased land. A railway facility area is established during the land readjustment process, and the consolidated land can be developed. Figure P.16 illustrates consolidated land readjustment.

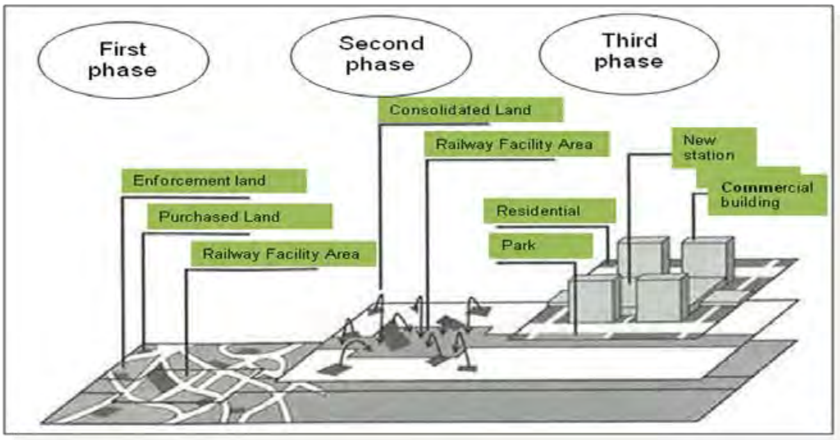


Figure P.16: Integrated Land Readjustment

P.5.4 Synergies of Integrated Development

The integrated approach to development had two main effects. First, it helped establish new communities. Developments taking place along the TX line include the Tsukuba Science City as well as the Kashiwanoha Campus City (a large-scale commercial and residential smart city development). These are regional communities that combine various academic, industrial, and cultural functions. It is also using the slogan “Tsukuba Style” to communicate the attractive lifestyle that it offers: a balanced mix of city life and nature and academia.

Second, the railway line has helped promote connections and interactions between and among the cities. With the Tsukuba Express connecting Tsukuba Science City with the Tokyo Metropolitan area, the various cities along the line are connected, and the cities contribute to each other’s development.