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Republic of Mozambique

Comprehensive Urban Transport Master Plan for the Greater Maputo

Final Report

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Contents

Technical Reports

Technical Report A

Socio-Economic Framework

Contents

Figures

Tables

Technical Report A Socio-Economic Framework

A.1 Introduction

This section covers the demographic framework which includes population growth, employment (workers) growth and enrolment (student) growth which is important to determine growth and changes in commute patterns. Furthermore, this section looks at economic growth (GDP/GRDP), which is also important to determining shifts in urban mobility and modality.

A.1.1 Urbanization in the Southern African Countries

Mozambique has been undergoing a general development towards urbanization. The Southern African region is the most urbanized region in the Sub-Saharan Africa. According to the Census 2007, around 31% of the total population in Mozambique lives in the urban areas. In 2011, Mozambique was ranked as the 8th urbanized country among the 12 Southern African countries as shown in Table A.1[1]. The average percentage of urban population in the Southern African countries in 2011 was 37.8%, and Mozambique was more urbanized compared to its neighbouring countries such as Malawi, Tanzania and Swaziland.

[1] There is no internationally recognized criterion to define urban areas. The United Nations (UN) document states "given the variety of situations in countries of the world, it is not possible or desirable to adopt uniform criteria to distinguish urban areas from rural areas". In order to improve the comparability of measurements of city population across countries, the UN uses a concept of "urban agglomeration", which refers to "the population contained within the contours of contiguous territory inhabited at urban levels of residential density". United Nations, World Urbanization Prospects, The 2011 Revision, Methodology, 2012.

Table A.1: Urban Population in the Eastern and Southern African Countries

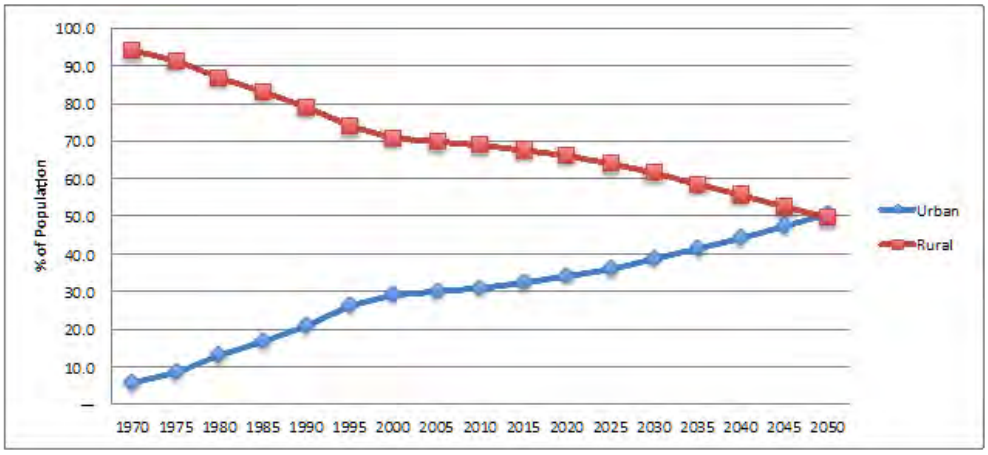
Major area, region, country or area	Population 2011 (thousands)			Percentage urban	Urbanization Ranking
	Urban	Rural	Total		
Sub-Saharan Africa	309,463	533,786	843,249	36.7	
Selected Southern African Countries	85,264	125,640	210,904	37.8	
Angola	11,613	8,006	19,618	59.2	3
Botswana	1,252	779	2,031	61.7	2
Lesotho	605	1,589	2,194	27.6	9
Madagascar	6,941	14,374	21,315	32.6	7
Malawi	2,410	12,971	15,381	15.7	12
Mozambique	7,463	16,467	23,930	31.2	8
Namibia	892	1,432	2,324	38.4	6
South Africa	31,282	19,178	50,460	62.0	1
Swaziland	256	948	1,203	21.2	11
Tanzania	12,351	33,867	46,218	26.7	10
Zambia	5,276	8,199	13,475	39.2	4
Zimbabwe	4,924	7,830	12,754	38.6	5

Sources: United Nations, World Urbanization Prospects, the 2011 Revision

A.1.2 Population Growth Trend in Mozambique

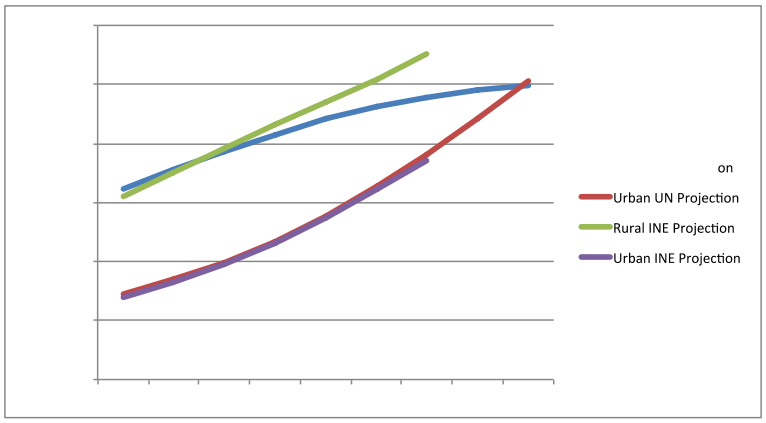
According to the United Nation's (UN) data, the urban population in Mozambique is projected to reach at 50% of the total population by 2050 as shown in Figure A.1. This growing urbanization may result from a natural growth of population, economic development, and the development of urban-based economic activities. The population growth rate in the urban areas will gradually decrease to 1.2% in 2030 and to 0.3% in 2050 when the society matures as developed countries.

The population projection undertaken by the National Institute of Statistics (INE) has a different perspective regarding the rural population growth. INE projects the urban population will grow by 3.44% between 2010 and 2015 on average. The growth rate will gradually decrease to 2.5% by 2025, and 2.1% by 2040, which are the similar projection to that of the UN. However, the rural population will continue to grow at the same growth rate as the urban areas between 2020 and 2040. Figure A.2 compares the projected population in rural and urban areas by the UN and INE between 2010 and 2050. The population in Mozambique is projected to attain 29.3 million by 2020, and 46.2 million by 2035.



Source: United Nations, World Urbanization Prospects, and the 2011 Revision.

Figure A.1: Population Projection in Urban and Rural Area in Mozambique



Source: United Nations, World Urbanization Prospects, the 2011 Revision; Data from INE.

Figure A.2: Urban and Rural Population in Mozambique Projected by UN and INE between 2010 and 2050

A.2 Population

A.2.1 Methodology

The population projection in the project area used to formulate the future traffic demand forecasts is formulated based on the latest available and official population data of the 2007 Census, as well as the INE population projection up to 2040 for Maputo Municipality, Matola Municipality, Marracuene District Administration, and Boane City Administration. The population projection is distributed according to the administrative boundaries based on provinces, districts, bairros (urban areas), localities (rural areas), and villages (rural areas).

According to the interview with INE, the cohort based population projection up to 2040 by INE is based on the following assumptions: 1) birth rate and fertility rate; and 2) mortality rate, including infant mortality, and 3) urban and rural migration. INE's projection considers not only urban-rural migration but also migration between provinces and between districts, including population migration to the Greater Maputo Region. However, this projection is based on past trends up to 2007 and the 2007 Census, and does not consider land use pattern and the future urbanization plans. Therefore, the study adopts the future total population in the project area projected by INE as a base, but changes the population distribution according to land use patterns and urbanization plans.

In this study, the following planning horizon is considered:

1) Year 2012: This is the current and base year of the study
2) Year 2018: The target year for the short-term development plan of the Master Plan
3) Year 2025: The target year for the medium-term development plan of the Master Plan
4) Year 2035: The target year for the long-term development plan of the Master Plan

A.2.2 Population Projection

The current and future population and population growth rate projected by INE are shown in Table A.2 and Table A.3. The population in the project area in 2012 accounts for 2.2 million, of which Maputo City consists of 54.8% of the total population. The population in Maputo City will reach at 1.5 million by 2035. The future concentration rate of population to Maputo City is expected to decline to 42.6% by 2035. On the other hand, the population in Matola is expected to grow from 0.8 million in 2012 to 1.7 million in 2035, overtaking the population of Maputo

Municipality and becoming the most populous city in the Greater Maputo Region. Marracuene and Boane are expected to grow more rapidly, increasing to triple the population between 2012 and 2035. The growth rates in Marracuene and Boane account for 7.4% and 6.1% in 2007 respectively, which is highest in the project area.

Table A.2: Current and Future Population Projected by INE (2012–2035)

Municipality/ District	CENSUS 2007		Current and Future Population Projected BY INE					
	Population	%	2012	%	2018	2025	2035	%
Maputo Municipality (Exc. Inhaca)	1,089,410	58.1	1,188,610	54.8	1,283,030	1,395,610	1,553,836	42.0
Matola	671,560	35.8	827,480	38.1	1,034,030	1,303,630	1,692,815	45.8
Marracuene	63,090	3.4	88,310	4.1	123,720	172,580	265,691	7.2
Boane	49,510	2.6	64,700	3.0	84,510	111,100	184,257	5.0
Total	1,873,570	100.0	2,169,090	100.0	2,525,300	2,982,920	3,696,599	100.0

Source: Data from INE

Note: The population in Marracuene and Boane in the table shows the population in the project area, and does not include the total population in districts.

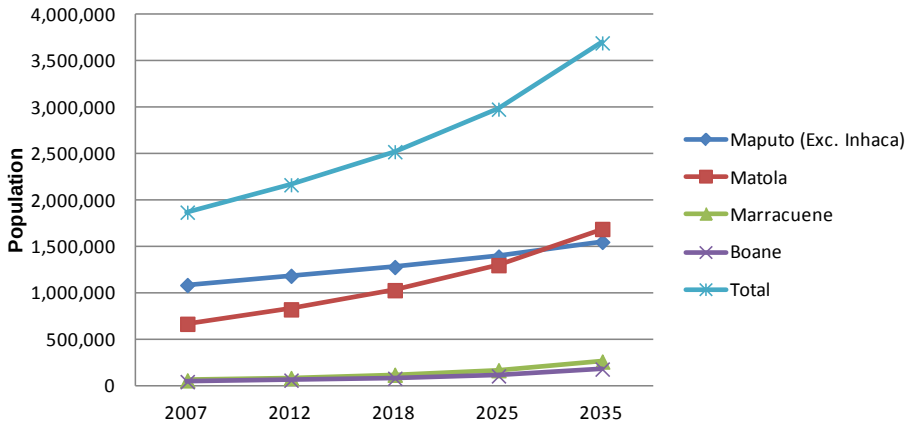
Table A.3: Current and Future Population Growth Rate Projected by INE (2012–2035)

	Growth (97/07) (%)	Projected Population Growth Rate (%)			
Municipality/ District	2007	2012	2018	2025	2035
Maputo Municipality (Exc. Inhaca)	1.3	1.8	1.3	1.2	1.1
Matola	4.7	4.3	3.8	3.4	2.7
Marracuene	7.4	7.0	5.8	4.9	4.0
Boane	6.1	5.5	4.6	4.0	3.5
Total Project Area	2.6–2.8*	3.0	2.6	2.4	2.1

Source: Data from INE

Note: *It is estimated that population in the total project area grew at 2.6% between 1997 and 2007, but this figure needs to be treated carefully since there was inconsistency in area data in Boane and Marracuene between 1997 and 2007. If all areas in Boane and Marracuene are included, the growth rate in the Greater Maputo Region between 1997 and 2007 is calculated at 2.8%.

Figure A.3 shows the evolution of population growth rate in Maputo municipality, Matola, Marracuene, and Boane between 1997 and 2035, using INE data. In particular, this figure demonstrates the significance of the population increase in Matola.



Source: Data from INE

Figure A.3: Population Growth by Municipality/District 2007 and 2035

The population above 6 years old in 2012 is required for a traffic demand forecast and is calculated by the following method:

Population (+6 years) in 2012 = Population (+5 years old) in 2012 − Population (0 year old) in 2007

The population of 0 year old in 2007 is expected to be the population of 5 years old by 2012, and thus the 0 year old population in 2007 is subtracted from the population of more than 5 years.

A.3 Employment

A.3.1 Methodology

The *Ficheiro de Unidade Estatísticass* (FUE) in INE conducted an enterprise survey for all registered companies in 2009, which is the most updated and official data on the formal working population in Mozambique. FUE's enterprise data, classified by districts based on economic activity classification (*Classificação das Actividades Económicas*: CAE) for 2008, 2009, and 2010 is used for the estimation of current and future working population. The working population classified by CAE is integrated into three sectors of industry, i.e., primary sector of industry (agriculture, etc.), secondary sector of industry (transformed industry, extractive industry, etc), and tertiary sector of industry (services, commerce, transport, etc.).

The 2007 Census provides the working population data by economic activities at the residence-basis at the bairros/locality level. This data includes both formal and informal labor, and is used for calculating the working population in the informal sector. The workable population (15 to 64 years old) is available from the 2007 Census, and the future workable population is based on the projection by INE up to 2035. The 1997 Census is used to analyze a trend of working population at the province level.

A.3.2 Employment Projection

It is assumed that the total working population is the economically active working population in the 2007 Census, including the formal and informal working population. The working population in the informal sector is estimated by subtracting the formal registered working population given by FUE from the total working population by the 2007 Census. It is assumed that primary (agriculture) sector workers work in the same district as their residence, and informal agriculture workers in the 2007 Census (residence) are distributed into the same district as to the working population at work place. In contrast, it is assumed that workers in the secondary (industrial) and tertiary (service) sectors often move beyond boundary of their residence, therefore, informal workers in those sectors are distributed according to the same weight as the formal workers by district.

A trend of working population growth rate between 1997 and 2007 and registered working population between 2008 and 2010 are used to estimate future employment. It is assumed that employment in Maputo Municipality will grow at the same growth rate of the formal sector as before (1.8%). On the other hand, employment in Matola and Boane is expected to grow at a higher growth rate than the average in Maputo Province, mainly due to the development of industrial and commercial activities along the Maputo Corridor. The participation rate in Maputo is expected to maintain constant, but the working population is expected to increase since female labor participation is anticipated gradually. It is assumed that Marracuene and Boane will maintain a high labor participation rate due to the dominance of the agriculture sector. However, the percentage share of working population in the agriculture sector is

anticipated to decline gradually as urbanization in these districts and the development of the industrial and service sectors are expected. Table A.4 summarizes the projected employment growth rate in the project area between 2012 and 2035.

Table A.4: Projected Employment Growth Rate (%) in Project Area (2012–2035)

Province/District	Growth rate in Census 97–07	Growth in FUE Data 08–10	2012	2018	2025	2035
Maputo Municipality	1.8*	1.4	2.5	2.0	2.0	1.5
Matola	3.7*	9.1	9.0	8.0	6.0	3.5
Marracuene	3.7*	−1.2	2.0	3.0	3.0	2.5
Boane	3.7*	1.9	3.5	5.0	5.0	3.5

Note: * indicates the growth rate of residence-based working population in Province
Source: JICA Project Team based on INE/FEU Data

In Maputo Municipality, industrial structure is expected to maintain constant, although small increase of the service sector is anticipated. In Matola and Boane, the industrial sector is expected to increase its share, based on the past trend and the expected development of industrial activities along the Maputo Corridor. The service sector is expected to grow in Matola, Boane, and Marracuene, which are led by the population increase, urbanization, and the subsequent growth in commercial activities. The development of the tourism sector in Marracuene (Macaneta) is expected, given the completion of the committed Incomati River Bridge.

The total future working population is calculated based on the residence-based workable population (ages 15–64). The working population at residence in the agriculture sector is distributed into the same district for work place while workers in the industrial and service sectors are expected to move beyond the residential area, and thus weighted based on the FUE's registered employment distribution in 2010. As the economy matures, the registered working population is expected to increase its share from 2025 onward. Table A.5 shows the projected working population by residence.

Table A.5: Estimated Working Population (by Residence)

	Estimated working population (by residence)			
	2012	2018	2025	2035
Maputo Municipality	391,690	441,106	499,778	574,324
Matola	257,842	345,533	446,093	599,512
Marracuene	42,574	58,703	79,887	107,362
Boane	48,180	62,742	80,912	103,574
Total	740,286	908,085	1,106,671	1,384,772

Source: JICA Project Team based on INE/FEU Data

Table A.6 shows a summary of projected employment at work place. These numbers are used for the transport demand forecast to determine the destinations of commute for workers. The disaggregation of working population to transport demand forecast model analysis zones will be made based on land use pattern.

Table A.6: Estimated Working Population (at Work Place)

	Estimated working population (at work place)			
	2012	**2018**	**2025**	**2035**
Maputo Municipality	560,188	630,862	724,663	841,001
Matola	118,454	187,972	282,640	398,691
Marracuene	22,082	26,367	32,428	41,511
Boane	39,194	52,523	73,906	104,251
Total	739,918	897,725	1,113,637	1,385,455

Source: JICA Project Team based on INE/FEU Data

Furthermore, a breakdown of employment between 2007 and 2035 is shown in Table A.7. The concentration rate of the working population to Maputo Municipality is expected to decline gradually from 75.7% in 2012 to 60.7% in 2035, mainly due to urbanization in the surrounding areas and the subsequent development of the industrial and service sectors.

Table A.7: Breakdown of Employment in the Project Area (2007–2035)

	1997	**2007**	**2012**	**2018**	**2025**	**2035**
Greater Maputo Region						
Population (exc. Inhaca, including all Boane and Marracuene)*	1,485,207	1,948,498	2,269,043	2,658,760	3,161,810	3,919,800
Labour Force Base Population (15–64) (a)	840,930	1,161,494	1,388,970	1,677,780	2,064,795	2,612,630
Employment at work place (b)		625,112	739,918	897,730	1,110,010	1,385,460
Agriculture		76,990	84,586	100,440	110,740	120,600
Industry		117,158	147,252	193,480	262,510	353,560
Service		430,964	508,080	603,800	736,770	911,300
Registered employment		261,728	233,173	277,370	372,500	562,300
Agriculture		5,757	6,113	6,790	8,440	11,100
Industry		34,901	46,292	59,570	89,040	154,940
Service		164,423	180,767	211,030	275,010	396,260
Informal Sector		420,031	506,745	620,360	741,140	823,160
Agriculture		71,233	78,473	93,650	102,300	109,500
Industry		82,258	100,959	133,910	173,470	198,620
Service		266,540	327,312	392,780	461,750	515,030
Participation Rate (b/a)		0.538	0.533	0.535	0.538	0.530
Maputo Municipality (exc. Inhaca)						
Population	962,165	1,089,412	1,188,612	1,283,030	1,395,610	1,559,650
Labour Force Base Population (15–64) (c)	557,639	671,066	751,039	836,060	944,310	1,068,490
Employment at work place (d)		495,124	560,188	630,860	724,660	841,000
Agriculture		19,985	22,408	22,710	23,910	25,230
Industry		82,562	89,630	97,150	108,700	117,740
Service		392,577	448,150	511,000	588,430	698,030
Registered employment		179,576	196,727	221,550	272,480	366,180
Agriculture		5,204	5,312	5,540	6,270	7,320
Industry		24,595	28,525	31,020	35,420	43,940
Service		149,778	162,890	184,990	230,790	314,920
Informal Sector		315,548	363,460	409,320	452,190	474,820
Agriculture		14,781	17,096	17,170	17,650	17,910
Industry		57,967	61,105	66,140	73,280	73,800
Service		242,800	285,260	326,010	357,640	383,130
Working Population in Maputo (Residence) (e)	300,959	358,264	391,690	441,110	499,780	574,320
Participation Rate (e/c)	0.540	0.534	0.522	0.528	0.529	0.540
Concentration rate to Maputo (d/b)		0.792	0.757	0.703	0.653	0.607
Agriculture		0.260	0.265	0.226	0.216	0.209

	1997	2007	2012	2018	2025	2035
Industry		0.705	0.609	0.502	0.414	0.333
Service		0.911	0.882	0.846	0.799	0.766
Matola City						
Population	424,662	827,475	827,475	1,034,030	1,303,630	1,692,820
Labour Force Base Population (15–64) (f)	230,609	388,272	502,806	658,590	862,560	1,157,960
Employment at work place		76,987	118,454	187,970	282,640	398,690
Registered employment		18,934	29,173	46,290	84,630	166,470
Agriculture		102	292	460	850	1,670
Industry		7,868	14,878	24,540	46,540	96,550
Service		10,964	14,003	21,300	37,240	68,250
Informal Sector		58,053	89,281	141,680	198,010	232,220
Agriculture		21,736	23,399	31,490	33,070	30,230
Industry		18,544	32,504	56,290	83,470	102,790
Service		17,773	33,379	53,890	81,470	99,200
Working Population in Matola (residence) (g)		197,284	257,842	345,530	446,090	599,510
Participation Rate (g/f)		0.508	0.513	0.525	0.517	0.518
Marracuene District						
Population	41,677	84,975	118,949	166,650	232,460	342,664
Labour Force Base Population (15–64) (h)	22,066	45,930	62,672	87,750	127,400	195,400
Employment at work place		20,000	22,082	26,370	32,430	41,510
Registered employment		1,208	1,201	1,390	1,900	3,090
Agriculture		23	24	60	110	250
Industry		102	96	110	190	370
Service		1,083	1,081	1,240	1,590	2,470
Informal Sector		18,792	20,881	24,970	30,530	38,420
Agriculture		16,796	18,083	20,510	23,240	26,740
Industry		241	346	680	1,430	1,710
Service		1,755	2,452	3,770	5,870	9,980
Working Population in Matola (residence) (i)		31,814	42,574	58,700	79,890	107,360
Participation Rate (i/h)		0.693	0.679	0.669	0.627	0.549
Boane City						
Population	56,703	102,555	134,006	175,040	230,120	324,670
Labour Force Base Population (15–64) (j)	30,616	56,226	72,452	95,380	130,530	190,790
Employment at work place		33,000	39,194	52,520	73,910	104,250
Registered employment		5,363	6,071	8,140	13,500	26,550
Agriculture		428	486	730	1,220	1,860
Industry		2,336	2,793	3,910	6,890	14,070
Service		2,598	2,793	3,500	5,400	10,620
Informal Sector		27,638	33,123	44,390	60,410	77,700
Agriculture		17,920	19,895	24,480	28,350	34,630
Industry		5,505	7,006	10,800	15,290	20,330
Service		4,212	6,222	9,110	16,770	22,740
Working Population in Boane (Residence) (k)		37,750	48,180	62,740	80,910	103,570
Participation Rate (k/j)		0.671	0.665	0.658	0.620	0.543

Source: JICA Project Team based on INE/FEU Data

A.4 Enrolment

A.4.1 Methodology

The current enrolment data at bairro/locality level in 2012 is provided by the Ministry of Education, Directory of Education in Maputo City and Maputo Province. INE provides the projected population data sorted by age groups up to 2040, which are used to estimate

enrolment age groups. Residence-based student population data from the 2007 Census is used estimate the residence-based student population. The 1997 Census is used for a trend analysis.

A.4.2 Enrolment Projection

Enrolment in the project area is estimated based on the enrolment rate to age groups, namely, 6–12 years old for primary schools, 13–17 years old for secondary schools, and 18–22 years old for higher education. Future enrolment is projected by a trend analysis using the 1997 and 2007 Census, and is based on gross enrolment rate (GER) and net enrolment rate (NER). GER is the gross number of students enrolled in each category of schools, while NER is calculated by applying the enrolled student population to each age group. GER in primary schools in the project area exceeds more than 100%, while the NER/GER ratio has been declining in primary and secondary schools between 1997 and 2007, implying that many over-age children participated in the education system.

Two methods are tested for a trend analysis. In the first method, the NER/GER in 2007 is applied for the projection of future enrolment in 2018–2035. This method results in over-estimation of enrolled students. The second method assumes that NER will increase gradually due to economic growth in the project area and a logistic trend is applied to estimate the future net enrolment rate. The latter method is found appropriate to estimate the future enrolment and the future NER/GER is calculated by a trend analysis between 1997 and 2012, applying a logistic estimation.

In Mozambique, technical schools consist of 1) elementary level (11–12 years old), 2) basic level (13–15 years old), 3) medium level (16–18 years old), and higher level (more than 18 years old). While higher technical institutes are categorized into higher education, other technical schools are normally joined into the category of technical schools. The study uses a trend of enrolment in medium technical schools in Maputo City for the projection of future enrolment. The following linear regression model is applied for calculating the future enrolment in technical schools:

$$E = 478.82X - 955913$$

Where E = Enrolment in technical school in Maputo City, X = year

The same trend of growth rate is applied for estimating enrolment in technical schools in Maputo Province (Matola, Marracuene, and Boane).

Table A.8 shows a summary of the projected student population. The disaggregation of enrolment to transport demand forecast model analysis zones will be made based on land use pattern.

Table A.8: Estimated Student Population

	Estimated student population			
	2012	**2018**	**2025**	**2035**
Maputo Municipality	359,141	385,237	427,683	422,378
Matola	238,124	302,676	404,112	493,341
Marracuene	31,429	46,993	68,842	95,864
Boane	32,882	45,954	62,580	83,186
Total	661,576	780,859	963,217	1,094,769

Source: JICA Project Team based on Ministry of Education and INE Data

Furthermore, the breakdown of enrolment in primary education, secondary education, technical schools, and higher education is shown in Table A.9.

Table A.9: Enrolment in the Project Area (2007–2035)

	1997	2007	2012	2018	2025	2035
Greater Maputo Region						
Population (exc. Inhaca, including all Boane and Marracuene)*	1,485,207	1,948,498	2,269,043	2,658,760	3,161,810	3,919,800
Educational Base Population	642,037	777,393	895,798	1,021,790	1,152,040	1,320,220
Age Group (6–12)	259,664	343,715	382,225	426,940	469,870	540,580
Age Group (13–17)	205,289	207,972	264,402	301,130	339,880	386,520
Age Group (18–22)	177,084	225,706	249,171	293,720	342,290	393,120
Enrolment			671,151	795,480	982,570	1,120,250
Primary School			452,338	506,210	560,140	639,290
Secondary School			156,728	193,540	289,460	293,230
Technical School			9,575	14,620	19,360	26,120
Higher Education			52,510	81,100	113,620	161,610
Students in the Project Area (Residence)		698,449	661,576	780,860	963,220	1,094,770
Primary School		463,987	452,338	506,210	560,140	639,290
Secondary School		179,496	156,728	193,540	289,460	293,230
Technical School		18,857				
Higher Education		36,109	52,510	81,100	113,620	162,250
Maputo City (exc. Inhaca)						
Population	962,165	1,089,412	1,188,612	1,283,030	1,395,610	1,559,650
Educational Base Population	413,781	431,959	460,118	469,050	462,900	456,120
Age Group (6–12)	157,648	184,955	188,868	191,930	187,260	187,890
Age Group (13–17)	137,037	113,777	137,692	137,750	136,250	133,830
Age Group (18–22)	119,096	133,227	133,558	139,380	139,380	134,400
Enrolment			386,925	469,460	594,660	688,040
Primary School			225,603	252,470	279,370	318,850
Secondary School			103,534	127,860	191,220	193,710
Technical School			6,776	10,350	13,700	18,490
Higher Education			51,012	78,790	110,380	157,000
Net Enrolment Rate (Residence, %)						
Primary School	0.91	0.76	0.77	0.79	0.80	0.83
Secondary School	0.09	0.21	0.27	0.34	0.42	0.54
Higher Education	0.00	0.05	0.07	0.10	0.13	0.18
Students in Maputo City (Residence)	286,713	407,218	359,141	385,240	427,680	422,380
Primary School	237,268	252,753	225,768	229,830	226,230	227,990
Secondary School	36,439	115,726	95,327	106,590	143,030	125,810
Technical School	7,808	12,212				
Higher Education	5,198	26,527	38,046	48,820	58,430	68,580
Matola City						
Population	424,662	671,556	827,475	1,034,030	1,303,630	1,692,820
Educational Base Population						
Age Group (6–12)	83,420	124,340	146,448	169,620	198,270	237,920
Age Group (13–17)	56,167	75,343	99,121	123,980	148,370	179,760
Age Group (18–22)	46,265	74,017	91,201	120,110	153,080	188,760
Enrolment			205,367	235,150	279,360	310,760
Primary School		150,272	164,930	184,570	204,240	233,100
Secondary School		26,426	38,274	47,270	70,690	71,610
Technical School		1,740	1,722	2,630	3,480	4,700
Higher Education			441	680	950	1,360

	1997	2007	2012	2018	2025	2035
Net Enrolment Rate (Residence, %)*						
Primary School	0.68	0.73	0.74	0.76	0.78	0.78
Secondary School	0.04	0.15	0.20	0.24	0.30	0.38
Higher Education	0.00	0.02	0.03	0.04	0.06	0.08
Students in Matola City (Residence)		234,800	238,124	302,680	404,110	493,340
Primary School		165,896	172,647	200,860	235,950	277,050
Secondary School		54,331	52,273	71,990	117,700	132,210
Technical School		5,992				
Higher Education		8,581	13,204	29,830	50,470	84,080
Marracuene District						
Population	41,677	84,975	118,949	166,650	232,460	342,660
Educational Base Population						
Age Group (6–12)	10,799	15,862	22,650	32,670	43,760	60,850
Age Group (13–17)	6,960	8,247	12,648	18,850	27,350	36,810
Age Group (18–22)	7,797	8,136	11,138	16,180	24,400	35,070
Enrolment		21,927	33,695	38,590	45,530	50,920
Primary School		20,417	27,620	30,910	34,200	39,040
Secondary School		1,510	5,476	6,760	10,110	10,250
Technical School			599	920	1,210	1,630
Higher Education			0	0	0	0
Net Enrolment Rate (Residence, %)*						
Primary School	0.68	0.72	0.73	0.75	0.77	0.79
Secondary School	0.04	0.10	0.13	0.17	0.21	0.27
Higher Education	0.00	0.01	0.01	0.01	0.02	0.02
Students in Marracuene District (Residence)		25,211	31,429	46,990	68,842	95,864
Primary School		20,446	26,400	38,250	51,490	72,080
Secondary School		4,113	4,500	7,670	15,220	18,980
Technical School		314				
Higher Education		338	529	1,070	2,140	4,800
Boane City						
Population	56,703	102,555	134,006	175,040	230,120	324,670
Educational Base Population						
Age Group (6–12)	7,797	18,558	24,259	32,720	40,580	53,920
Age Group (13–17)	5,125	10,605	14,941	20,560	27,910	36,130
Age Group (18–22)	3,926	10,326	13,274	18,040	25,430	34,890
Enrolment			47,151	52,280	63,030	70,540
Primary School		24,204	36,172	38,260	42,330	48,310
Secondary School		3,775	9,444	11,660	17,440	17,670
Technical School		209	478	730	970	1,300
Higher Education			1,057	1,630	2,290	3,250
Net Enrolment Rate (Residence, %)*						
Primary School	0.68	0.70	0.71	0.73	0.75	0.77
Secondary School	0.04	0.09	0.12	0.15	0.18	0.23
Higher Education	0.00	0.01	0.01	0.01	0.02	0.02
Students in Boane City (Residence)		31,220	32,882	45,954	62,580	83,186
Primary School		24,892	27,523	37,280	46,480	62,170
Secondary School		5,326	4,628	7,290	13,520	16,220
Technical School		339				
Higher Education		663	731	1,380	2,590	4,800

Source: JICA Project Team based on Ministry of Education and INE Data

A.5 Economic Performance

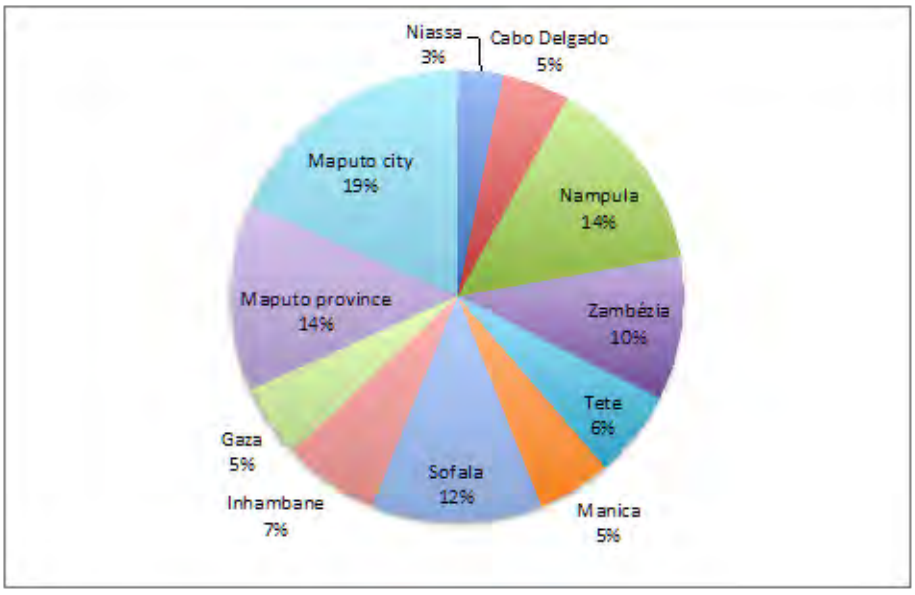
A.5.1 Historical GDP/GRDP

Since the end of civil war in 1992, Mozambique has experienced strong macroeconomic growth and been relatively resilience to external shocks. The average GDP growth between 2001 and 2009 in Mozambique is estimated at 8.2%, which is higher than the average GDP growth in the Sub-Saharan Africa (6.5% between 2004 and 2008).

Although exports have declined massively and private investments has been stagnated during the global economic crisis, the economy in Mozambique has been largely resilient to this adverse impact, as the economy sustained to grow over 6.0% between 2007 and 2009. The financial market in Mozambique has been less dependent on capital markets in Europe and United States, which was considered as the main reason for relative resilience of the Mozambican economy to the global economic crisis.

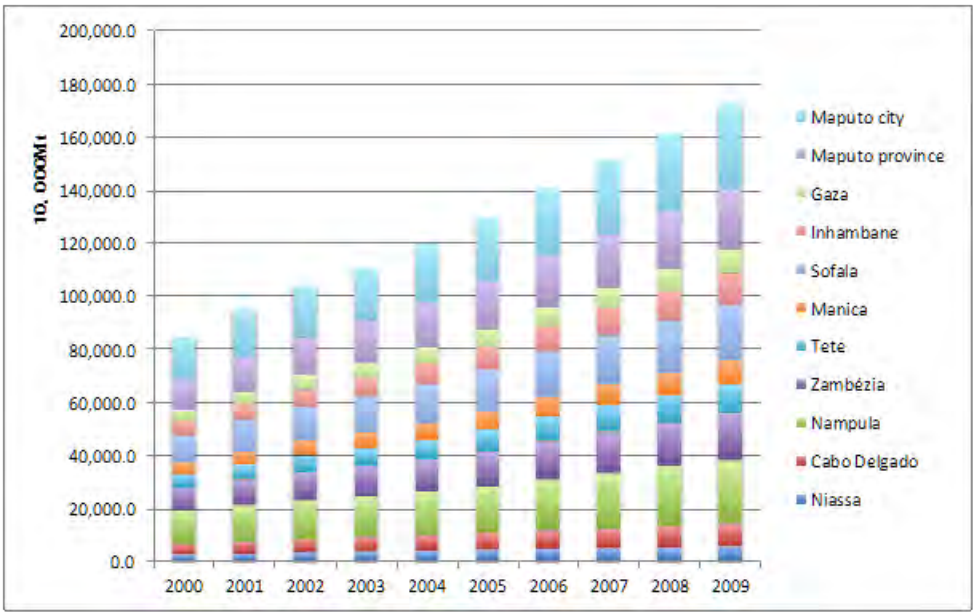
Economic activities have been gradually recovering from the global economic crisis partly due to easing macroeconomic policies and increasing inflow of private investments. According to the government of Mozambique, the economy in Mozambique is projected to grow at 7.7% between 2011 and 2014, and IMF estimates the growth rate in 2011 at 7.2%.

Maputo Municipality is the largest regional economy in Mozambique, comprising of 19% of the national GDP, followed by Maputo Province as shown in Figure A.4. Both Maputo Municipality 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 Figure A.5.



Source: Data from INE

Figure A.4: Gross Regional Domestic Product (GRDP) in 2009 by Province: Constant Prince in 2003 (in Percent of the National GDP)



Source: Data from INE

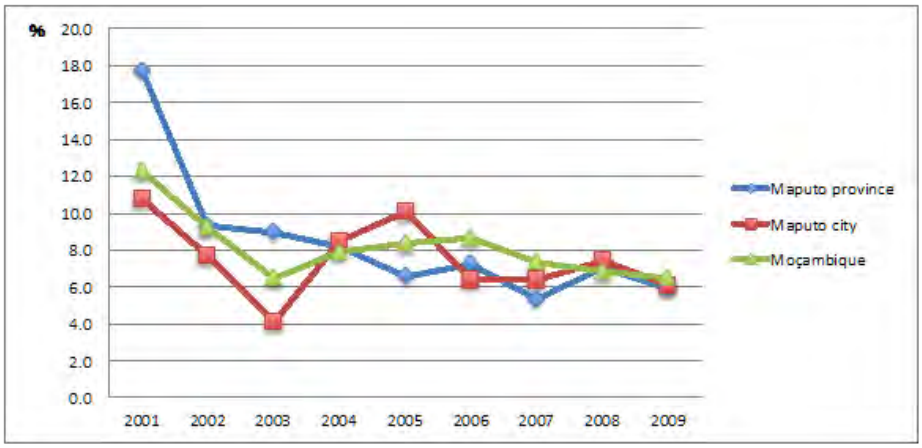
Figure A.5: Gross Regional Domestic Product (GRDP) by Province between 2000 and 2009: Constant Price in 2003 (10,000 MT)

Table A.10 shows the GDP and GRDP growth rates by province between 2001 and 2009. 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 were more adverse impacts from the global economic crisis in 2007 and 2009 when the growth rate recorded at 5.3% and 5.9% respectively as shown in Figure A.6. 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.

Table A.10: 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 Municipality	10.8	7.7	4.0	8.4	10.1	6.4	6.4	7.4	6.1
Mozambique	**12.3**	**9.2**	**6.5**	**7.9**	**8.4**	**8.7**	**7.3**	**6.8**	**6.4**

Source: Data from INE



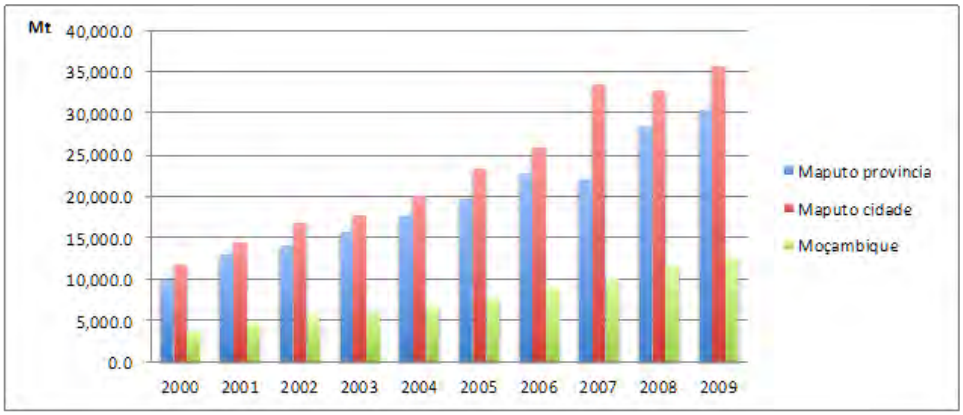
Source: Data from INE

Figure A.6: GDP and GRDP Growth Rate in Maputo City, Maputo Province, and Mozambique between 2001 and 2009

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 MT 3,807 (equivalent to USD 251) in 2000 to MT 12,616 (equivalent to USD 454) in 2009 (Figure A.7). The GDP per capita in Maputo City and Maputo Province are highest in Mozambique (Figure A.8). At the current price, GDP per capita in Maputo City and Maputo Province in 2009 stand at MT 35,735 (USD 1,285) and MT 30,479 (USD 1,079) respectively, which are around 3 times more than the national average.

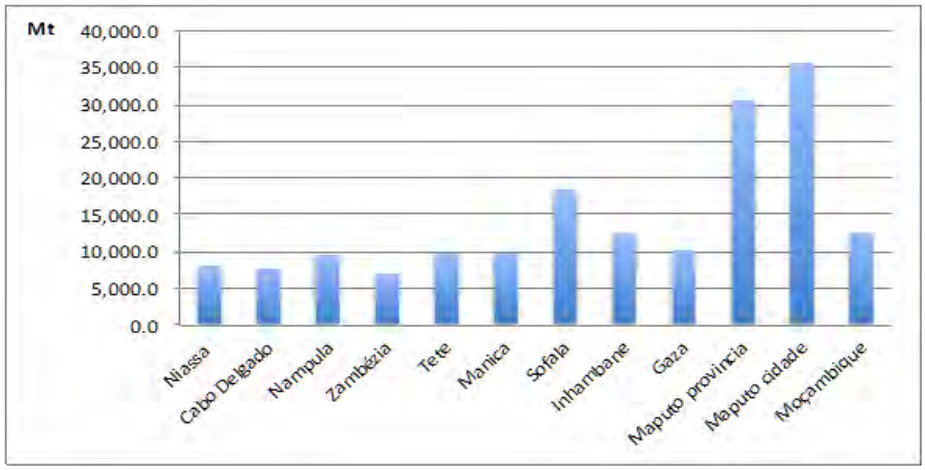
However, the driving force of growth in Mozambique mainly results from the large foreign investments such as Mozal while the development of small and medium enterprises (SMEs) has been relatively far behind. For instance, the number of SMEs in 2002 was registered at 28,474, which was very low considering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

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



Source: Data from INE

Figure A.7: Increase of GDP per Capita by Province between 2000 and 2009 (Current Price, MT)



Source: Data from INE

Figure A.8: GRDP per Capita by Province in 2009 (Current Price, MT)

A.5.2 GDP/GRDP Projection

As described in Chapter 1, the economy in Mozambique has been robust, growing at the average economic growth rate of 8.2%. Economic activities have been recovering from the global economic crisis and economy in Mozambique is expected to grow at 8.4% in 2013. The extractive sector in Mozambique is expected to grow rapidly, owning to coal and natural gas development, and will contribute to increase the economic growth in the medium term.

According to the projection by MPD, the GDP in Mozambique is expected to grow steadily by 2025 at the average growth rate of 8.6% between 2021 and 2025, mainly due to the growth of the extractive sector (coal, LNG, etc.) and infrastructure, as well as the subsequent development of the industry and commercial sectors. Economy will have reached a level of relative maturity. With reference to current GDP rates of stable economies, the average GDP growth rate of 5.5% per year is applied after 2031.

GDP in Maputo Municipality has been growing at 7.5% between 2001 and 2009, which is slightly lower than the national level. Based on the trend analysis, future GDP in Maputo Municipality is expected to grow at around 7.3% by 2017, due developments such as the Ka Tembe urbanization project and various transport developments. The economy in Maputo City would have reached a level of relative maturity, leading to a gradual decrease in growth rate, and an average 4.0 % growth rate is applied after 2031.

Maputo Province has experienced strong economic growth in the past decade, growing at the average of 8.5% between 2001 and 2009. The aluminum factory of Mozal and other industrial activities in Matola and Boane contributed to boosting the economy in Maputo Province. Further development of industrial parks and port facilities, as well as industrial and commercial activities along the Maputo Corridor. Thus, the GDP in Maputo Province is anticipated to grow at a similar high growth rate as national economy. Upon reaching relative maturity, a 5.5% average growth rate is applied after 2031.

Table A.11 shows a detailed breakdown of the GDP/GRDP/GRDP per capita projection between 2012 and 2035 for Maputo Municipality and Maputo Province (including Matola City, Boane City, and Marracuene District) are shown.

Table A.11: GDP/GRDP Growth Projection (2012–2035)

	Unit	2009 (Actual)	2010 (Est.)	2011 (Est.)	2012 (Proj.)	2018 (Proj.)	2025 (Proj.)	2035 (Proj.)
Mozambique								
Population		21,802,866	22,416,881	23,049,621	23,700,720	27,843,930	33,165,000	41,553,730
Real GDP (at 2003 constant price)	Mil. MT	171,873	184,050	197,525	212,360	337,920	597,610	1,083,190
Real GDP (at 2009 constant price)	Mil. MT	266,213	285,114	305,927	328,870	523,320	925,490	1,677,490
Real GDP growth rate	%	6.4%	7.1%	7.3%	7.5%	8.2%	8.6%	5.1%
GDP per capita (at 2009 constant price)	MT	12,918	12,719	13,273	13,880	18,800	27,910	40,370
GDP per capital (at 2009 constant price)	USD	457	385	491	500	670	1,000	1,440
GDP per capital growth rate (real)	%	4.0%	4.2%	4.4%	4.5%	5.4%	6.0%	2.8%
Maputo Municipality								
Population		1,145,307	1,161,833	1,178,116	1,194,120	1,288,720	1,401,480	1,565,770
Real GDP (at 2003 constant price)	Mil. MT	31,696	33,693	35,917	38,400	58,000	89,280	138,630
Real GDP (at 2009 constant price)	Mil. MT	47,379	50,364	53,688	57,390	86,700	133,450	207,220
Real GDP growth rate	%	6.1%	6.3%	6.6%	6.9%	7.0%	5.5%	4.0%
GDP per capita (at 2009 constant price)	MT	47,379	43,348	45,571	48,060	67,270	95,220	132,350
GDP per capita (at 2009 constant price)	USD	1,549	1,314	1,687	1,720	2,400	3,400	4,720
GDP per capital growth rate (real)	%	3.9%	4.8%	5.1%	5.5%	5.7%	4.3%	2.9%
Maputo Province								
Population		1,329,395	1,385,604	1,444,624	1,506,440	1,937,920	2,588,340	3,804,760
Real GDP (at 2003 constant price)	Mil. MT	22,950	24,442	26,153	28,040	43,470	74,700	135,410
Real GDP (at 2009 constant price)	Mil. MT	35,081	37,361	39,976	42,860	67,190	115,470	209,290
Real GDP growth rate	%	5.9%	6.5%	7.0%	7.2%	7.8%	7.8%	5.1%
GDP per capita (at 2009 constant price)	MT	26,389	26,964	27,673	28,450	34,670	44,610	55,010
GDP per capita (at 2009 constant price)	USD	988	817	1,024	1,020	1,240	1,590	1,960
GDP per capital growth rate (real)	%	3.5%	2.2%	2.6%	2.8%	3.4%	3.5%	1.4%

Source: Actual data from INE, estimation and projection data between 2010 and 2025 from MPD, and JICA Project Team

Note: Exchange rates between 2009 and 2012 are based on the data from Statistical Year Book 2010 by INE and the data from Bank of Mozambique. Thereafter, the exchange rate in 2012 (July) is applied.

For the purpose of the transport demand forecast modeling, the GDP/GRDP growth projection for the Greater Maputo summarized in Table A.12 will be used.

Table A.12: GDP/GRDP Growth Projection (2012–2035)

	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

A.5.3 GDP Structure by Industry

The extractive sector in Mozambique is expected to grow rapidly in the medium term. Mozambique's natural resource reserves (coal, natural gas, and mineral sands) have not been fully explored. According to the preliminary estimate of IMF, the mega projects in Mozambique can directly contribute up to 18% of total value added by 2016, of which the coal extraction may consist of around 9% of the total GDP.

The tertiary (service) sector has grown at 7% on average in the past decade, and is expected to continue to grow at a similar growth rate mainly due to the gradual urbanization as well as the development of the transport sector necessary to transport natural resources along the corridors. However, the boost of the extractive sector may result in the decrease of share in the service sector. Accordingly, the percentage structure of the service sector in total value added is expected to grow rather slower than in the past.

The primary industry is expected to decline the percentage share of GDP, mainly due to the gradual population movement between rural-urban areas in Mozambique and growth in the other sectors.

For this study, it is assumed that the economic structure after 2020 would be maintained constant as before. Table A.13 and Table A.14 summarize the current and future GDP by industry in Mozambique between 2009 and 2035.

Table A.13: Percentage Structure of GDP by Industry in Mozambique (2009–2035) (%)

		Secondary Industry					
	Primary Industry	Total	Extractive Industry	Manufac-turing	Electricity /Water	Construc-tion	Tertiary Industry
2009	25.2	22.3	1.1	12.8	4.9	3.4	43.6
2010	25.1	21.8	1.2	12.4	4.8	3.4	44.1
2011	24.9	21.3	1.3	11.9	4.8	3.3	44.0
2012	24.3	21.8	1.9	11.5	5.1	3.3	48.1
2013	23.7	22.3	3.0	11.0	5.0	3.3	44.5
2014	22.8	23.2	5.0	10.5	4.5	3.2	44.7
2015	20.8	25.4	8.0	10.2	4.0	3.2	44.5
2016	20.4	25.6	9.0	10.0	3.5	3.1	44.7
2017	17.9	28.3	12.0	10.0	3.2	3.1	44.5
2018–2020*	15.7	30.7	15.0	9.8	2.9	3.0	44.3
2021–2025*	14.7	31.6	16.0	9.8	2.8	3.0	44.4
2026–2030*	14.7	31.6	16.0	9.8	2.8	3.0	44.4
2031–2035*	14.7	31.6	16.0	9.8	2.8	3.0	44.4

Source: Actual data from INE (2009), estimation and projection by MPD (2010–2013), and JICA Project Team
Note: *indicate the average figures.

Table A.14: GDP by Industry in Mozambique (2009–2035, Constant Price in 2003) (Million MT)

		Secondary Sector of Industry					
	Primary Industry	Total	Extractive Ind.	Manufac-turing	Electricity/ Water	Construc-tion	Tertiary Industry
2009	43,252	38,170	1,910	21,910	8,420	5,920	74,450
2010	46,130	40,170	2,150	22,890	8,900	6,240	80,510
2011	49,690	42,090	2,500	23,570	9,490	6,530	85,250
2012	51,600	46,230	4,090	24,390	10,720	7,030	102,140
2013	54,550	51,330	7,010	25,320	11,570	7,590	102,370
2014	56,520	57,570	12,410	26,050	11,170	7,940	110,970
2015	55,730	67,940	21,400	27,280	10,700	8,560	118,940
2016	58,850	73,890	25,980	28,860	10,100	8,950	129,040
2017	56,040	88,380	37,470	31,230	9,990	9,680	138,830
2018–2020*	57,270	112,520	55,150	35,900	10,480	10,990	162,500
2021–2025*	74,990	161,200	81,620	49,990	14,280	15,300	226,490
2026–2030*	107,800	231,740	117,340	71,870	20,530	22,000	325,610
2031–2035*	143,990	309,530	156,720	95,990	27,430	29,390	434,900

Source: Actual data in 2009 from INE, estimation and projection in 2010–2013 by MPD, and JICA Project Team
Note: * indicates the average figures.

A.6 Urban Poverty and Transport

The gradual urbanization in the Greater Maputo implies significant shifts in the social fabric and the economic expenditure patterns of its population. In particular, the recent population movement from the city centre to the suburban areas in Matola and other neighbouring districts may increase transport costs for the population to work in the city centre or go to schools/ universities in Maputo. In addition, unplanned rapid growth of the suburban area may aggravate the living conditions of households, causing more people to be without an access to adequate public services, and may create traffic congestion.

Nonetheless, poverty in the Maputo Municipality has been decreasing with Table A.15 outlining that the poverty headcount index[2] in Maputo Municipality dropped from 47.8% in 1996–97 to 36.2% in 2008–09. It should be noted that the rapid reduction of poverty incidence in KaMpfumo (DM1) from 16.0% to 2.0% is mainly due to the exclusion of two other districts, namely, KaTembe and KaNyaka (Inhaca Island) in the calculation of poverty in 2008–09. However, poverty levels have slightly increased in Matola City, Marracuene, and Boane. Around 46% of the population in Matola live in conditions below the poverty line. On the other hand, as shown in Section 2.2, per capita GDP has been rising at the rate of 8.5% on average in Maputo Province. This increase in poverty levels in Matola, Boane, and Marracuene is mainly due to the following:

- A possible migration of poorer strata of the population to the suburban area due to the increasing living expenses in the Maputo Municipality.
- The increase of living expenses of the residents of Matola, Boane, and Marracuene, in particular, transport costs to commute to the city centre.

[2] The headcount index is defined as the proportion of people whose consumption (per capita) is below the poverty line. The level of poverty is measured by the national poverty index or poverty line, which is set at 18 meticais or about USD 0.50.

Table A.15: Poverty Incidence (Headcount Index) in the Project Area and Mozambique

	Poverty Incidence (Headcount Index)		
Province/District	**1996–97**	**2002–03**	**2008–09**
Maputo Municipality	47.8	53.6	36.2
KaMpfumo (DM1)*	16.0		2.0
Nlhamankulu (DM2)	45.0		35.0
KaMaxaquene (DM3)	50.0		23.0
KaMavota (DM4)	50.0		25.0
KaMubukwana (DM5)	49.0		32.0
Maputo Province	65.6	69.3	67.5
Matola City	44.0		46.0
Boane	60.0		65.0
Marracuene	57.0		68.0
Urban	62.0	51.5	49.6
Rural	71.3	55.3	56.9
Mozambique	69.4	54.1	54.7

Source: MPD, District Poverty Maps for Mozambique 1997 and 2007; Poverty Reduction Action Plan (PARP) 2011–2014.

*Municipal district Ka Tembe and KaNyaka (Inhaca) were separated from KaMpfumo district after 1997. The poverty headcount index in 2007 excludes poverty index from these two districts. The poverty rate of the aggregated area of KaMpfumo, Katembe, and KaNyaka is calculated at 15%.

Although the improvement in the incidence of poverty was seen in Maputo, inequality measured by Gini[3] remained the same between 1997 and 2009 (Table A.16). It seems that increasing urbanization and economic growth may not extend to the poorest population in Maputo Municipality. On the other hand, Maputo Province demonstrated a slight improvement in terms of equality during the same period.

Table A.16: Inequality by GINI Coefficient in Mozambique

	Inequality GINI		
Zone	**1996–97**	**2002–2003**	**2008–2009**
Maputo Municipality	0.52	0.52	0.51
Maputo Province	0.43	0.43	0.39
Gaza	0.41	0.41	0.43
Inhambane	0.44	0.44	0.38
Urban	0.47	0.48	0.48
Rural	0.37	0.37	0.37
National	0.40	0.42	0.41

Source: GOM, Poverty Reduction Action Plan (PARP) 2011–2014

[3] Gini co-efficient is based on the Lorenz curve, which captures the degree of equality in terms of consumption per capita. Zero in Gini co-efficient represents no in equality in society and the measure approaches one as inequality increases.

Technical Report B

Greater Maputo's Growth Trends and Land Use

Contents

Figures

Technical Report B Greater Maputo's Growth Trends and Land Use

B.1 Introduction

This section explores the existing land uses of Greater Maputo derived from Plano de Estrutura Urbana do Municipio de Maputo (PEUMM – Urban Structure Plan for Maputo Municipality), Plano de Estrutura Urabana da Cidade da Matola (PEUCM – Urban Structure Plan for Matola City) and the CENACARTA land cover maps for Boane and Marracuene. Furthermore, the section identifies growth potentials and trends, as well as physical development constraints in the region.

B.2 Greater Maputo's Growth Trends

The capital and economic centre of Mozambique, "Greater Maputo" (which includes Maputo City excluding Inhaca, Matola City, the eastern portion of Boane City, and the southern half of Marracuene District) has experienced rapid growth in the past decade. With the City of Maputo as a centre for the country's business and institutional functions, Matola and Matola Rio (Boane) are home to the various export, manufacturing and agri-industries.

Figure B.1 shows the boundary of Greater Maputo, its existing and planned major transport infrastructure, and the assets that have, and will continue to be, the foundation of the socio-economic growth of the greater metropolitan region.

Source: JICA Project Team based on information from Google Maps, MICOA

Figure B.1: Boundary of Greater Maputo

B.2.1 Maputo Development Corridor

The Maputo Development Corridor (A in Figure B.1) originates in Maputo and terminates in Johannesburg, connecting the deepwater ports of Maputo and Matola to the northern area of Southern Africa via the EN4 highway and the Mozambique-South African border of Ressano Garcia/Lebombo. The Maputo Development Corridor includes 92 km of road, rail, border posts, port, and terminal facilities.[1]

B.2.2 Matola Port

Matola Port (B in Figure B.1) and deep water bulk terminals mainly handle bulk cargo, such as coal, aluminium, light and heavy fuels, mineral oil projects and cereals. The port is associated with export and manufacturing industries including the new Mozal Aluminium Terminal and the Oil Terminal.

The Matola Coal Terminal in Matola Port is an important outlet for South African coal mining. Mpumalanga Province of South Africa, which contains the bulk of South Africa's electricity generating coal fired power station, which accounts for 76% of South Africa's coal mining output and 50% of the national coal reserves. Much of the coal extracted from this region is transported through the Maputo Corridor and exported via the Matola Coal Terminal in Matola Port.[2]

The Matola Port Bulk Terminals provides the following services[3]

1. Grain Terminal;
2. Goal Terminal;
3. Petroleum Terminal; and
4. Aluminium Terminal.

B.2.3 Maputo Port

Maputo Port (C in Figure B.1) in contrast to Matola Port, handles all other cargo, including general cargo, containers, and some specialized cargo. The port has a total area of approximately 129 hectares with 3,000 metres of continuous wharves of depths ranging from 8–12 metres.

The Maputo Port Bulk Terminals provides the following services[4]

1. MIPS Container Terminal;
2. Citrus Terminal;
3. Molasses Terminal;
4. Bulk Sugar Terminal;
5. Bagged Sugar Terminal; and
6. Coastal Terminal.

B.2.4 Belaluene Industrial Park and Mozal Aluminium Smelter

The Belaluene Industrial Park and the Mozal Aluminium Smelter (D in Figure B.1) are among the largest industrial centres of the country.

[1] MCLI (Maputo Corridor Logistics Initiative)
[2] MCLI (Maputo Corridor Logistics Initiative), Mpumalanga Department of Economic Development and Planning
[3] PEUMM
[4] PEUMM

B.3 Major Characteristics of Existing Land Use

This section summarizes Greater Maputo's growth trends by breaking down the current land use pattern by land use type and assessing its development potential. The JICA Project Team compiled an existing land use pattern map based on existing structure plans, geographic information system (GIS) remote sensing, satellite imagery, and interviews with urban planning officials. Much of the existing land use map for Maputo Municipality and Matola City is based on the *Plano de Estrutura Urbana do Município de Maputo* (PEUMM – Maputo Municipality Urban Structure Plan 2008) and the *Plano de Estrutura Urbana da Cidade da Matola* (PEUCM – Matola City Urban Structure Plan 2010). The maps have been updated by overlaying satellite imagery and information from interviews to track developments in recent years. Although Boane City and Marracuene District are developing an existing land use plan, due to the schedule of this project, existing land use in these two districts were compiled based on GIS remote sensing, satellite imagery, and information from interviews.

Classes of land use are categorized as follows.[5]

1. Residential Use
   a) High Density, Medium Density, Low Density, No Occupation
   b) Planned, Unplanned
2. Commercial and Mixed Use
   a) Mixed Use
   b) Commercial Only
3. Industrial Use
   a) Industry - Storage and Repair
   b) Industry - Extractive
4. Institutional (Social Infrastructure and Public Services)
   a) Institutional (Social Infrastructure and Public Services)
   b) Special Uses (i.e. cemetery)
5. Agro-Livestock
6. Others (all other uses including parking, etc.)

B.3.1 Natural Boundaries and Agriculture

Figure B.2 shows the natural boundaries and land classified for agriculture in Greater Maputo.

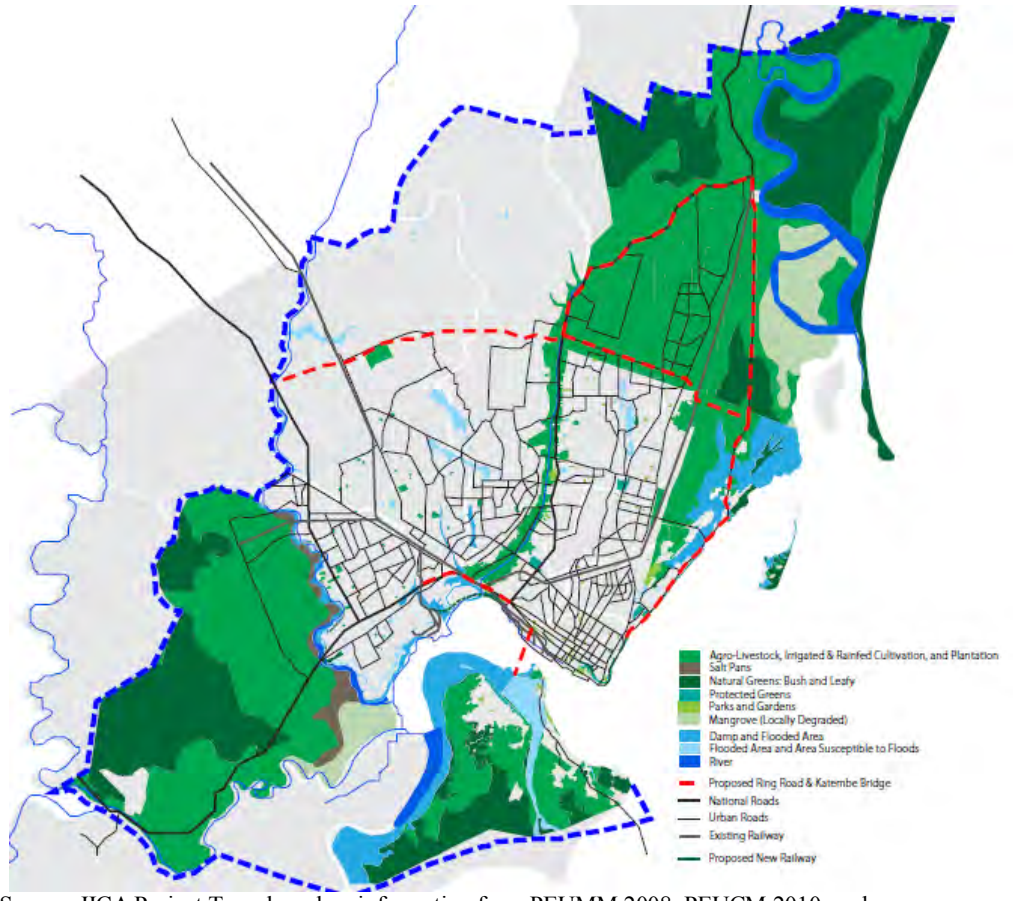
The river which runs along the boundary of Maputo and Matola, as well the river along the boundary of Matola and Boane, are major bottlenecks to urban mobility as traffic must be channelled to a limited number of bridges, which often leads to traffic congestion and delays.

Figure B.2 also suggests that much of Boane, Marracuene, and KaTembe are categorized as agro-livestock, cultivation, and plantation land. Given anticipated residential developments in KaTembe, as well as already occurring developments in Boane and Marracuene, it is suggested that much of the agricultural landscape in Greater Maputo will drastically change within the time frame of this master plan.

Furthermore, it is essential to realize that as a low altitude city, Greater Maputo has various areas that are highly susceptible to flooding during the rainy season. Urban development

[5] Based on PEUMM and PEUCM, consolidated by JICA Project Team

(especially residential build up) into the current agricultural and natural areas may lead to exposure to natural disasters and requires careful examination prior to development.



Source: JICA Project Team based on information from PEUMM 2008, PEUCM 2010, and CENACARTA Land Cover 1997

Figure B.2: Natural and Agricultural Land Use Distribution and Major Transport Infrastructure

B.3.2 Residential Land Use

Residential land use makes up a significant portion of urban development in Greater Maputo as shown in Figure B.3. High and middle density residential is centred near the southern half of Matola and Maputo, while recent developments are occurring in the northern areas of Matola and Maputo.

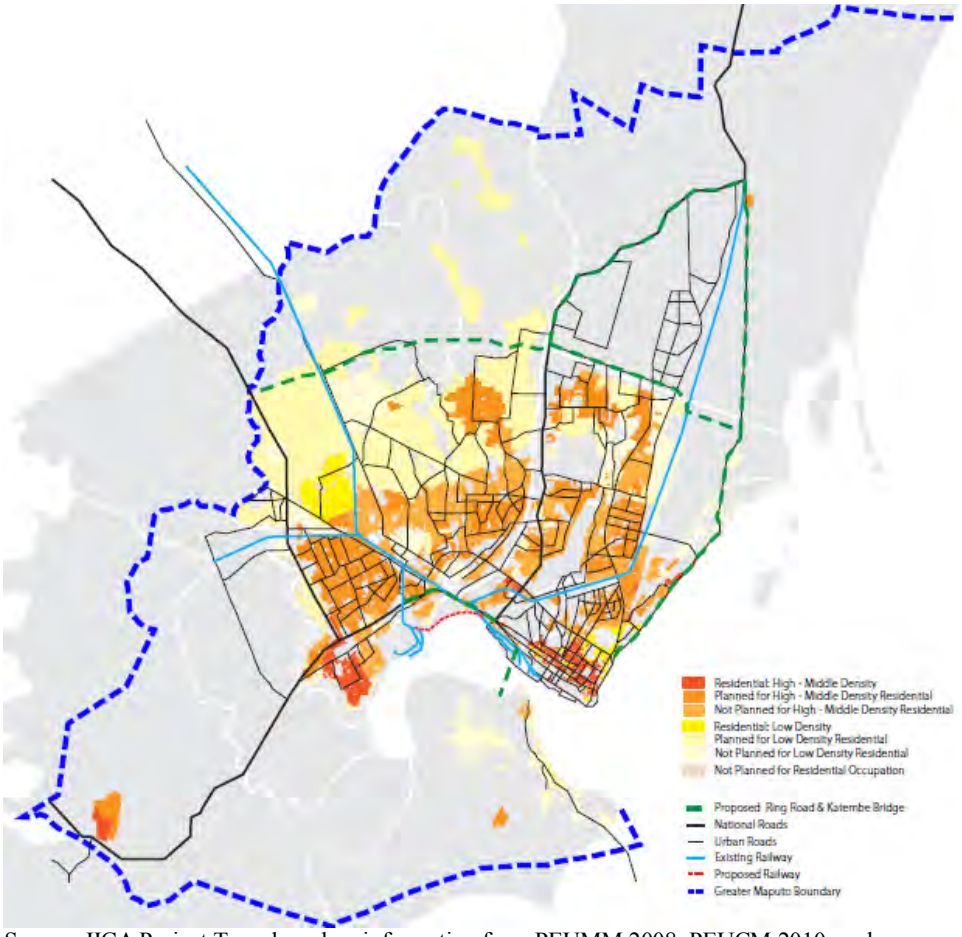
In PEUMM and PEUCM, the following residential typologies are identified.

1. Urbanized Space:
   a) Multifunctional area (housing, commerce and services);
   b) Consolidated Area with High Density Residential (> 60 dwellings per ha);
   c) Consolidated Area with Medium Density Residential (> 20 < 60 dwellings per ha); and
   d) Consolidated Area with Low Density Residential (< 20 dwellings per ha).

2. Space under Urbanization:
   a) Planned or Demarcated for High Density Residential (> 60 dwellings per ha);

b) Planned or Demarcated Medium Density Residential (> 20 < 60 dwellings per ha);
c) Planned or Demarcated for Low Density Residential (< 20 dwellings per ha);
d) Not Planned or Demarcated with High Density Residential (> 60 dwellings per ha);
e) Not Planned or Demarcated with Medium Density Residential (> 20 < 60 dwellings per ha); and
f) Not Planned or Demarcated with Low Density Residential (< 21 dwellings per ha).

While the information in Figure B.3 taken from the Urban Structure Plans of Matola and Maputo suggests that residential development is consolidated within Matola and Maputo, field surveys and population data suggest that much of the new residential development is spreading to Boane and Marracuene. With a lack of an urban structure master plan for Boane and Marracuene, it is difficult to control development patterns, and may lead to urban sprawl. From an urban transport view, urban sprawl is a challenge to infrastructure development since the provision of affordable and efficient transport modes to an appropriate catchment area becomes difficult.

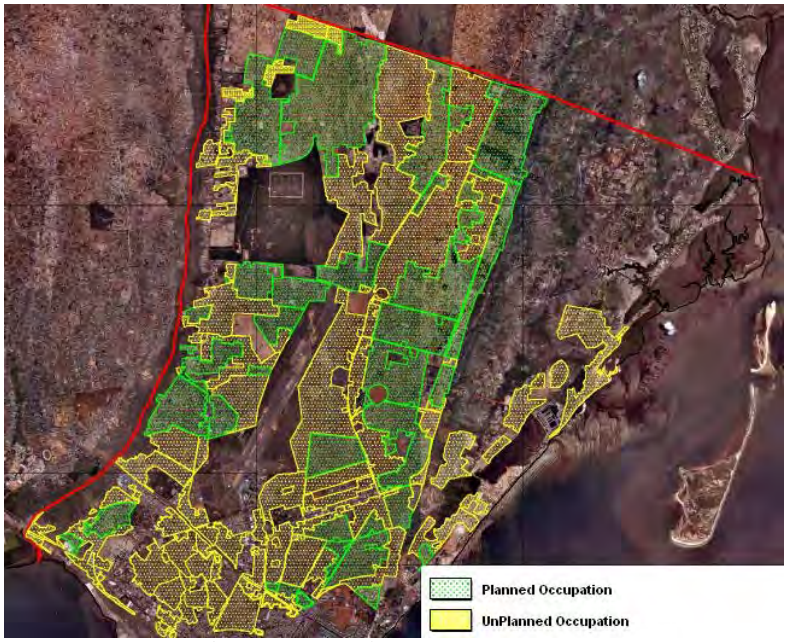


Source: JICA Project Team based on information from PEUMM 2008, PEUCM 2010, and CENACARTA Land Cover 1997

Figure B.3: Residential Land Use Distribution and Major Transport Infrastructure

Furthermore, the existence of a large population of informal residential settlements is a major challenge to strategic urban development. Approximately 75% of the Maputo Municipality population lives in non demarcated informal settlements as shown in Figure B.4. Such type of informal settlements can also be seen emerging in Matola City along the N2, as well as in Marracuene District along the border of Maputo Municipality, to name a few. Many of these

settlements are often in inappropriate areas susceptible to floods and erosion as shown in Figure B.5. Furthermore, the newer settlements emerging in the outskirts of the city are further prone to natural disasters.



Source: ProMaputo Phase II Presentation, 2011

Figure B.4: Distribution of Planned and Unplanned Settlements

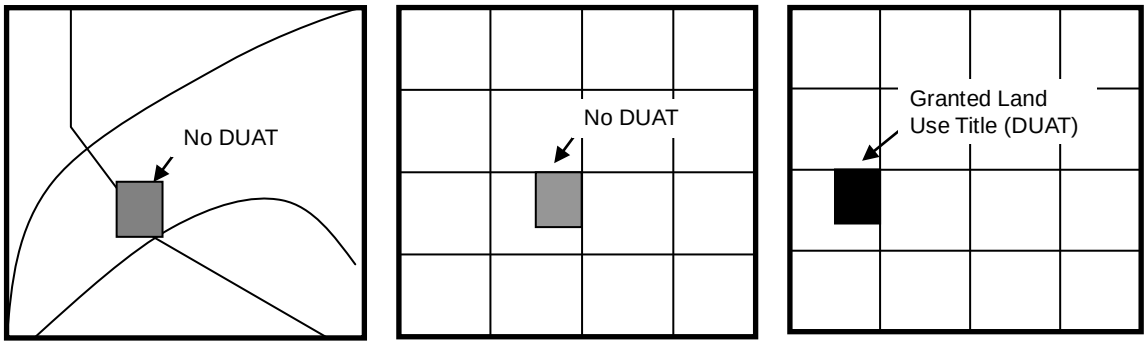
Source: ProMaputo Phase II Presentation, 2011

Figure B.5: Informal Settlements Susceptible to Flooding

Figure B.6 depicts the distinction between unplanned and informal residential settlements as described below. Informal settlements are settlements which have not been formalized. Formalization refers to the documentation of legal land title (also known as the DUAT – right to the use of land) hence, informal settlements are settlements in which DUATs have not been granted.

Informal settlements may be planned or unplanned. Planned settlements refer to those where plans have been legislatively approved.

In areas with informal settlements, the first step of integration of such settlements into the formal urban fabric is to legalize the development plans, thereby improving the urban conditions and providing access to urban infrastructure. Once this initial step is achieved, the next step is formalization of settlements via the granting of land use title (DUAT).



Unplanned and Informal Settlements | **Planned and Informal Settlements** | **Planned and Formal Settlements**

Source: JICA Project Team

Figure B.6: Distinction between Informal and Unplanned Settlements

B.3.3 Institutional Land Use

As the capital of the country, Maputo hosts the facilities of the government, diplomatic missions (embassies), and major international organizations. While the dense concentration of institutional land uses around the Maputo and Matola central business districts are inevitable, institutional land use distribution follows a similar trend to that of the residential land use distribution (Figure B.7). Institutional uses are distributed throughout the city to satisfy the needs of the local neighbourhoods and are most often accessible by existing infrastructure.

Source: JICA Project Team based on information from PEUMM 2008, PEUCM 2010, and CENACARTA Land Cover 1997

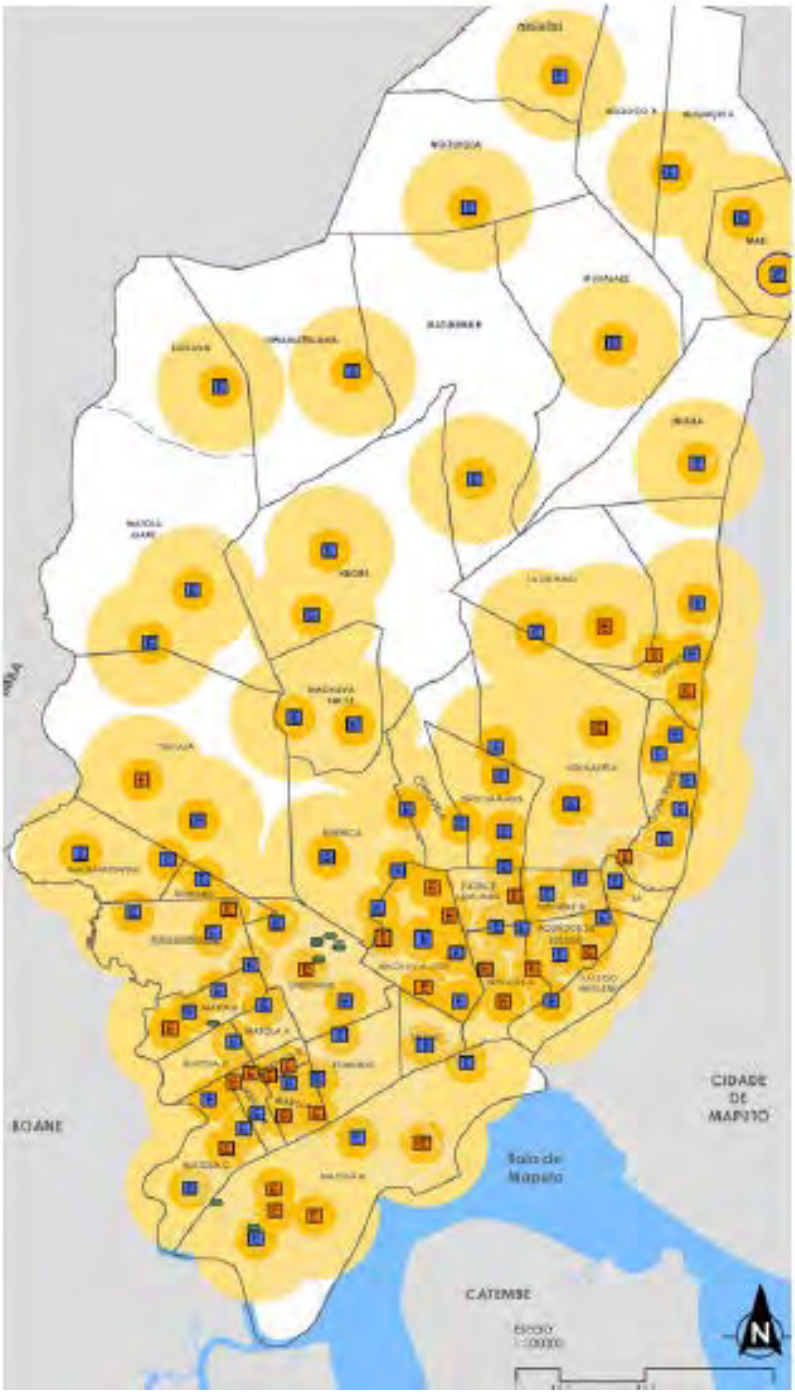
Figure B.7: Institutional Land Use Distribution and Major Transport Infrastructure

B.3.4 Schools

Similar to institutional uses, primary and secondary schools are distributed throughout the city for local neighbourhoods. Figure B.8 and Figure B.9 show the distribution of schools, showing the catchment radius of 0.5 kilometres for primary schools, and 1.5 kilometres for secondary schools. Furthermore, Greater Maputo benefits from several universities and technical schools which attract students from the whole country. The distribution of student enrolment is further discussed in Technical Report A.

Source: JICA Project Team based on information from PEUMM 2008

Figure B.8: Schools in Maputo Municipality



Source: PEUCM

Figure B.9: Schools in Matola City

B.3.5 Tourism, Commercial, and Mixed Use

Figure B.10 shows the distribution of tourist attractions such as historically classified areas and architectural heritage sites, commercial and mixed use land use, and other major tourist attractions. Many of the attractions are centred in Maputo CBD with some natural and event driven facilities located outside of the CBD.

Source: JICA Project Team based on information from PEUMM 2008, PEUCM 2010, and CENACARTA Land Cover 1997

Figure B.10: Mixed Use, Commercial, Tourism and Major Transport Infrastructure

(1) National Parks

Greater Maputo is no exception from the country's strategy of a destination for tourism. In the Maputo area, there is a large amount of tourism potential including the Kruger Transfrontier Park which Mozambique shares with South Africa and Swaziland, and the Maputo Special Reserve (formerly Maputo Elephant Reserve).

(2) Hotels

In anticipation for the 2010 Football World Cup hosted in South Africa, there was a mini-boom in hotel construction, including a large scale upgrade of the Polana Hotel and the new Radisson Hotel.

(3) Zimpeto National Stadium

Furthermore, in anticipation of the All Africa Games (Football) 2011 hosted by Mozambique, a multi-use stadium with a capacity of 42,000 spectators has been constructed in Zimpeto (B in Figure B.10) with funding from the Chinese Government. In addition to the stadium construction, there were various road upgrades as well as the development of the Olympic village.[6]

(4) Joaquim Chissano International Business Conference Center

The Joaquim Chissano International Business Conference Center (JCICC) (C in Figure B.10) completed in 2003 has hosted various global business and institutional events, and attracts international delegates.

(5) International Airport

Maputo International Airport (D in Figure B.10) is currently going under modernization and upgrade at an initial estimated cost of 75 M USD (with a cost overrun) financed by the Chinese Government. The new international passenger terminal which opened in 2010 holds a capacity of 900,000 passengers per year. With the possibility of expanding to 3 million passengers per year in the future, the second terminal is currently under construction. In addition to the new passenger terminals, a new cargo terminal has been financed by Aeroportos de Mozambique (ADM).[7]

B.3.6 Offices, Business, Finance and Services

While the PEUMM and PEUCM do not highlight office land use, it is evident that much of the nation's major office and business is concentrated in Greater Maputo. In terms of financial services, while a majority of bank branches are located in Maputo Province, most of the commercial banks are concentrated in Maputo. The Confederation of Business Associates (CTA), representing 70 business federations, associations, and chambers of commerce, is headquartered in Maputo.[8] The distribution of employment in the tertiary (service) sector is further discussed in Technical Report A.

B.3.7 Industrial Land Use

While Matola is the capital of Maputo Province, it is also the country's main industrial center, with the largest concentration of industry in the country. Figure B.11 shows the distribution of Sorting, Repairing and Extractive industries in Greater Maputo. Major assets for industrial growth in the region are summarized below. The distribution of employment in the secondary (industry) sector is further discussed in Technical Report A.

[6] Mozambique High Commission
[7] World Bank, Prospects for Growth Poles in Mozambique, 2010
[8] World Bank, Prospects for Growth Poles in Mozambique, 2010

Source: JICA Project Team based on information from PEUMM 2008, PEUCM 2010, and CENACARTA Land Cover 1997

Figure B.11: Industrial Land Use and Major Transport Infrastructure

(1) Belaluene Industrial Park and Matola Industrial Zone

Belaluene Industrial Park (BIP) (A in Figure B.11), which is the country's largest industrial park, was established in 2007 with the World Banks' Private Sector Development Project (PODE) finance. The park is located in the Matola Industrial Zone in Boane City. The Park is approximately 15 km from the Matola Port, immediately west of the Matola River, and a few hundred meters north east of the Mozal Aluminium Plant. The Park occupies approximately 60 hectares. The Belaluene Industrial Park is a located on a land parcel which is a private land concession awarded by the Government of Mozambique which degrees that no communities are allowed to settle in the land within the park.

(2) Mozal Aluminium Smelter

The Mozal Aluminium Smelter in Matola (B in Figure B.11) is the area's first megaproject in the region, developed in order to establish itself as a favourable environment. The 2.8B USD project involves a joint venture of companies from Australia, Japan, South Africa, and a minority stake by the Government of Mozambique. The Alumina is sources in Australia, and

the output of about 506,000 tons of aluminium ingots per year is mainly exported to the European Union.

(3) Other Export and Manufacturing

Other large manufacturing and processing companies (beer, soft drink, cement, and cereal milling industries, such as Cimentos de Mozambique, Cervejas de Mozambique, Coca-Cola) are located in Greater Maputo. As shown in Figure B.11, much of these export and manufacturing industries are located along the EN 4 route with convenient access to the Matola Port (C in Figure B.11)[9]. Furthermore, proximity to the Maputo International Airport and its cargo terminal (E in Figure B.11) also are beneficial to the transport of products that require speedy transport.

(4) Agri-Business

There are also large agri-businesses such as the Maragara sugar mill and Bananalandia, which supply products to both domestic and South African markets, such products are most likely exported via the land route on the Maputo Corridor (F in Figure B.11) or via the ocean route through Maputo Port (E in Figure B.11).

[9] World Bank, Prospects for Growth Poles in Mozambique, 2010

Technical Report C

City Planning Regulations and Practices

Contents

Figures

Tables

Technical Report C City Planning Regulations and Practices

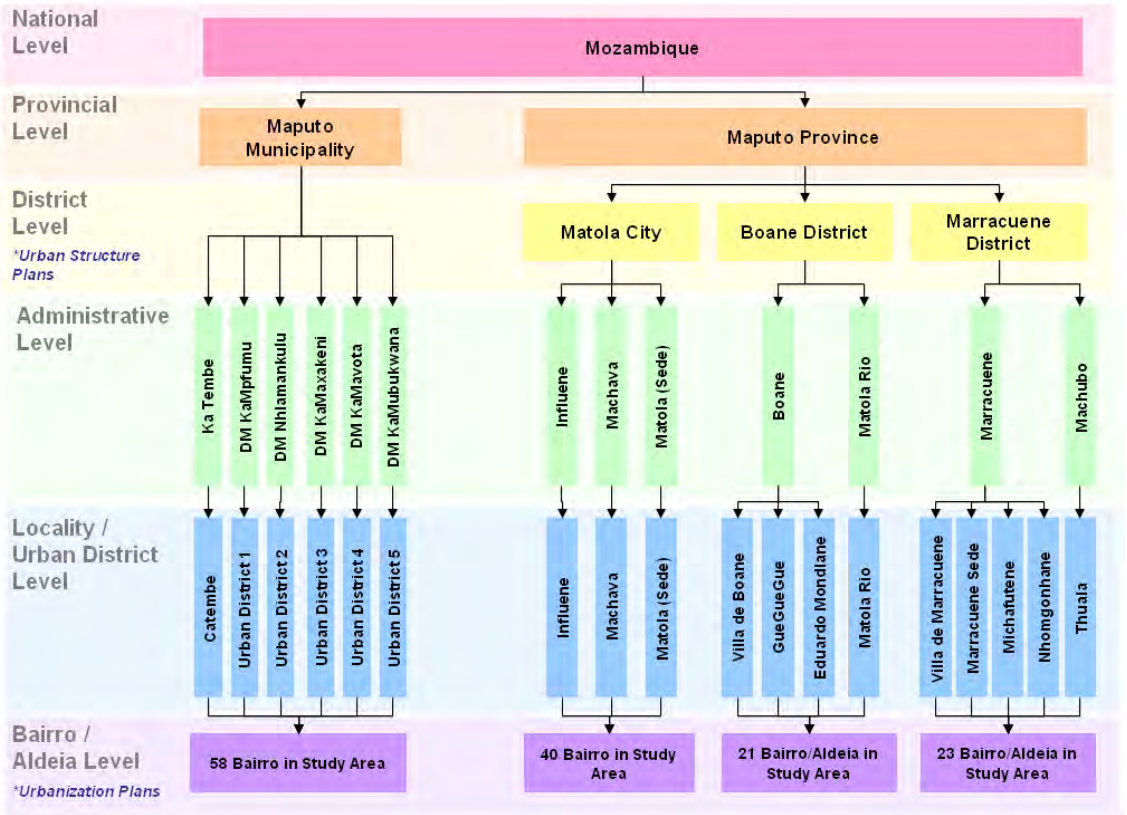
C.1 Introduction

This section reviews the regulations and legislations governing the urban and land use planning practices of Greater Maputo. Furthermore, urban development recommendations for Greater Maputo are made based on the review of existing Urban Structure Plans of Maputo (PEUMM) and Matola (PEUCM), components of ProMaputo, consultancy meetings with Boane and Marracuene District Service of Planning and Infrastructure (SDPI – Servico Distrital de Planamento e Infra-estrutara) , and urban planning technical working groups.

C.2 Review of Urban Planning Institutional Structure

(1) Greater Maputo

Much of the challenge of urban planning is a result of the lack of institutional capacity. As shown in Figure C.1, Maputo Municipality is considered to have a similar authority to Maputo Province. Matola City, Boane[1] and Marracuene District are cities and districts within Maputo Province.



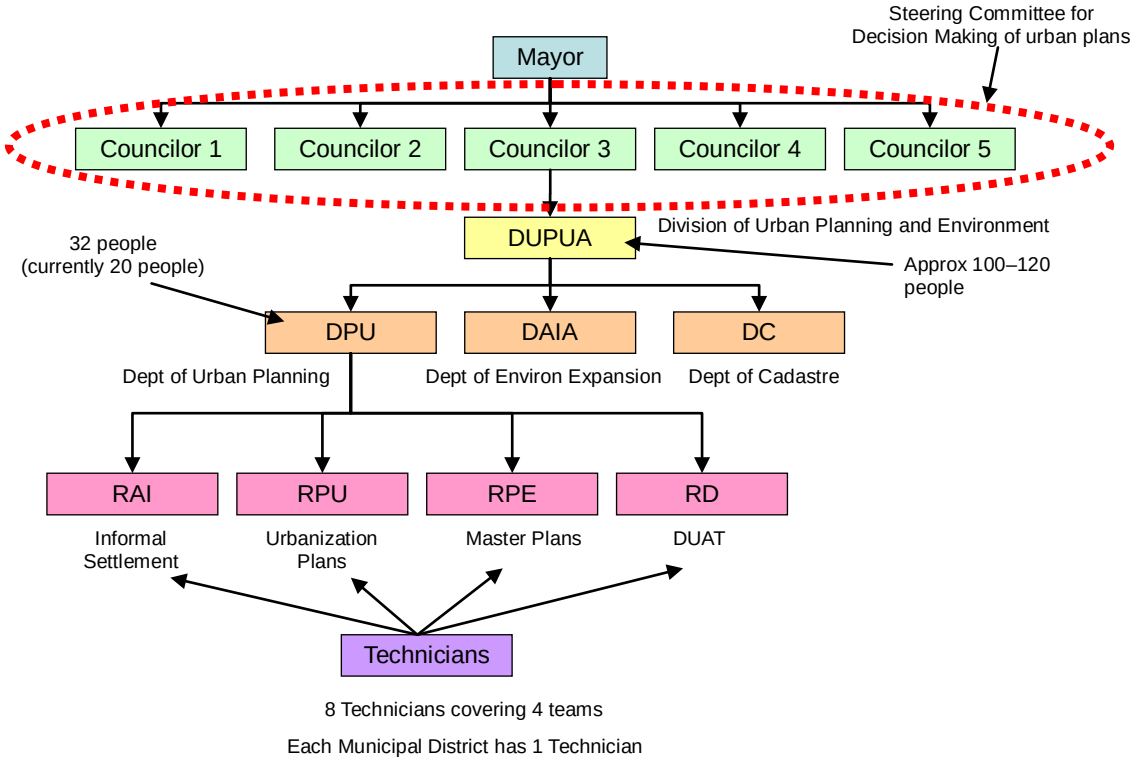
Source: JICA Project Team

Figure C.1: Administrative Structure of Greater Maputo and Positioning of Urban Development Plans

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

(2) Maputo Municipality

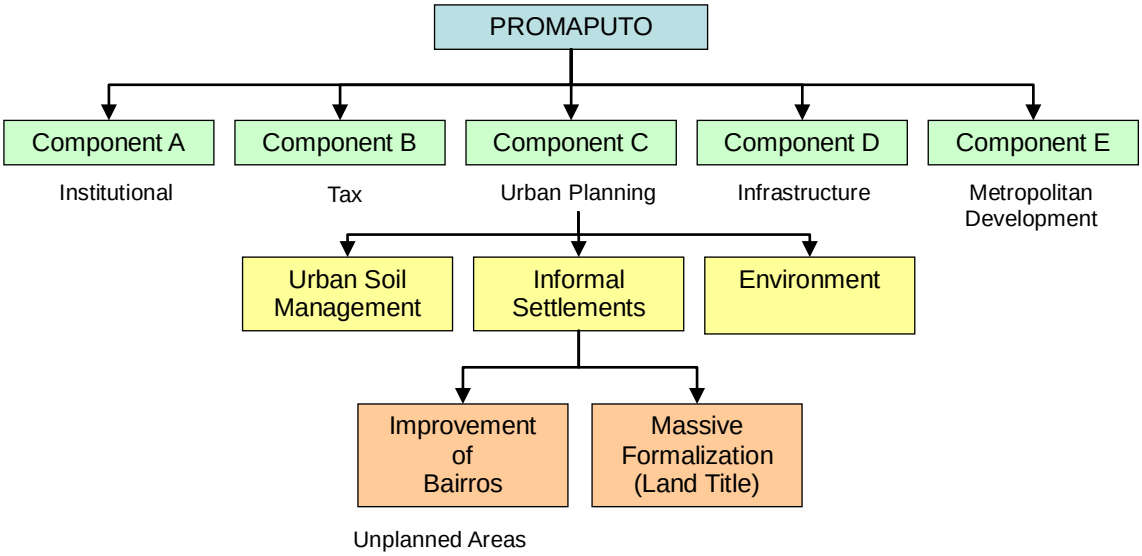
Figure C.2 shows the organizational structure of the Maputo Municipality Division of Urban Planning and Environment based on an interview conducted with the Department of Urban Planning.



Source: JICA Project Team based in Interview with Maputo Municipality Department of Urban Planning

Figure C.2: Institutional Structure of Maputo Municipality Division of Urban Planning and Environment

Furthermore, significant institutional assistance from the World Bank has been provided to the Maputo Municipality Division of Urban Planning and Environment as part of ProMaputo. Figure C.3 shows the structure of ProMaputo and its Urban Planning components

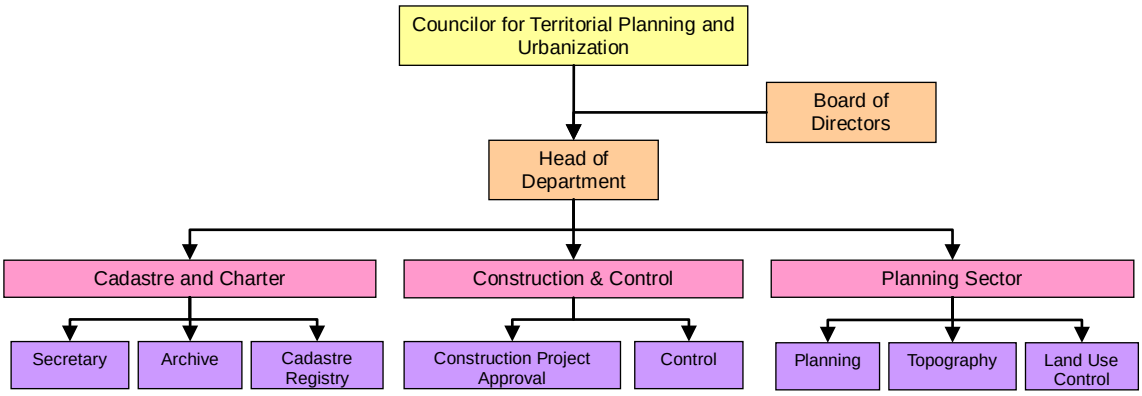


Source: JICA Project Team based in Interview with Maputo Municipality and the World Bank.

Figure C.3: Structure of ProMaputo

(3) Matola City

Figure C.4 shows the organizational structure of the Maputo Municipality Division of Urban Planning and Environment based on an interview conducted with the Department of Urban Planning.



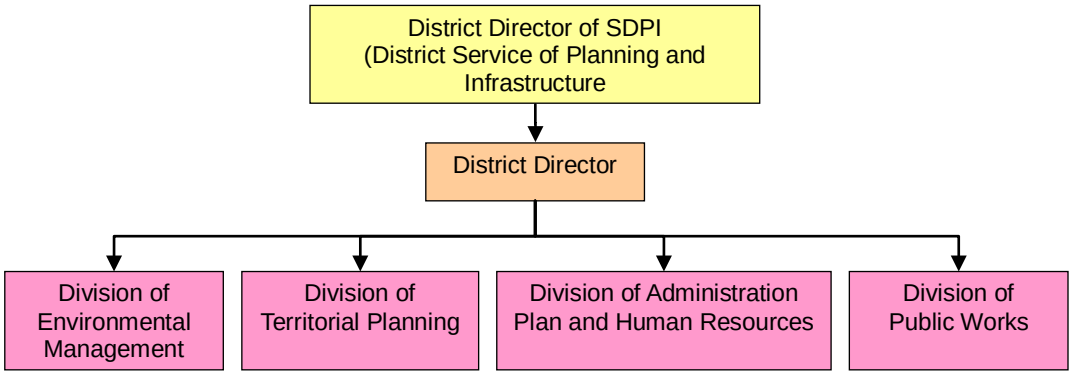
Source: JICA Project Team based in Interview with Matola City

Figure C.4: Institutional Structure of Matola City Division of Territorial Planning and Urbanization

(4) Boane[2] and Marracuene District

Figure C.5 shows the institutional structure of the Boane and Marracuene District Service of Planning and Infrastructure (SDPI – Servico Distrital de Planamento e Infra-estrutara) which applies to every district by law. Currently Marracuene District SDPI has 19 employees while Boane City SPDI has 15 employees.

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



Source: JICA Project Team based in Interview with Boane and Marracuene

Figure C.5: Institutional Structure of Boane and Marracuene SDPI

(5) Institutional Challenges

As shown in the above sections, the largest institutional challenge in terms of urban planning in Greater Maputo is the lack of institutional capacity. While there is much area for technical skills development, the major issue at hand is the lack of human resource, especially in Boane and Marracuene which employ less than 20 members. The shortage of manpower and lack of operating budget for SDPI is closely linked. While DUAT and building permit registrations are one source of revenue for the districts, due to the lack of manpower to conduct field surveys, it is impossible to fully check the registration status of the large area of land lots. Development of an official land use and structure plan for Boane and Marracuene (which are currently being conducted) as well as institutional assistance are necessary for Boane and Marracuene.

C.3 Review of Urban Planning Legislations

Along with the shortage of institutional capacity, a major challenge for urban development in Greater Maputo is the transparency and the proper civic education of Land Use and Urban Planning laws and regulations explored in this section.

(1) DUAT – Right to the Use of and Benefit of Land

In Mozambique, established by the constitution of the Republic of Mozambique, ownership of land is the exclusive right of the state. Land belonging to the state cannot be sold, alienated, mortgaged or encumbered. While the ownership, power and the ability to determine the condition of its use lies with the state, however, national individuals, corporate persons, or local communities can be granted the right to the use and benefit of land called DUAT (*direito de uso e aproveitamento dos terros)*[3]. Foreign individuals and corporate persons may be holders of the right of land use, provided that have an investment project that is duly approved with the following conditions: a) individuals must have been resident in the Republic of Mozambique for at least five years; and b) corporate persons must be established or registered in the Republic of Mozambique[4].

The acquisition of the DUAT is conducted through the following three methods and the title is issued by the general or local Public Cadastre (Registry) Services.

1. Occupancy by individual persons and by local communities, in accordance with customary norms and practices which do not contradict the Constitution;

[3] USAID, Land Rights for the Commercial Activities in Mozambique, 2007.
[4] MOZLEGAL, Land Law Regulation, 2004.

2. Occupancy by individual national persons who have been using the land in good faith for at least ten years; and
3. Authorization of an application submitted by an individual or corporate person in the manner established by this Law

DUAT for the purpose of economic activity is subject to a maximum term of 50 years, which is renewable for another 50 years upon application. After 50 years, a new application must be submitted. In the case that the DUAT is: a) acquired by local communities through occupancy; b) intended for personal residential purposes; or c) national individual persons intended for family use, the DUAT is not subject to a time limit[5].

Title holders of the DUAT are subject to fees according the to the lot location, dimension, and purpose of the land use. The fees involved are authorization fee and annual fees where preferential fees are established for national citizens.[6]

(2) National Land Law of 1997 (Law 19/97)

The Land Law of 1997 approved by Decree 16/87 in July 1997, seeks to achieve the following by formalizing the process and terms of the DUAT described in Section C.2.(1).

1. Rationalize and regularize land granting;
2. Legitimize existing grants;
3. Moderate granting through criteria and standard procedures; and
4. Reaffirm the rights of peasant landholding communities.

The collection of legislation covers the key aspects of land occupation and use. Various conditions are regulated, including the acquisition, process, and terms of the DUAT, the rights and duties of the title holders, the rules governing protection zones, and the authority and responsibilities of the Cadastre Services.[7]

(3) Spatial (Territorial) Planning Law (LOT) (Law 19/2007)

The Spatial Planning Law 19/2007 (LOT – *Lei de Ordenamento do Território*) of 18 July 2007 applies to the entire national territory for the purposes of spatial (territorial) planning. The regulation is aimed at the articulation of rules and implementation of the Spatial Planning Law to ensure that occupation and use of national space in a more socially equitable, productive and sustainable manner.

In the context of land use planning, this regulation aims to ensure that the current occupation of physical space for people and national communities are considered as the most important element in any intervention of spatial planning, land use planning, natural resources or heritage of the built environment.[8]

(4) Civic Education

A common challenge experienced universally by Maputo Municipality, Matola City, Boane City and Marracuene District are the issue of native (often informal) settlements. While the Land Law of 1997 states the rights of native inhabitants after a certain period of occupation, often municipalities and districts encounter challenges with native inhabitants regarding new development plans. The need for proper civic education regarding land laws, public hearings,

[5] Same as Above.
[6] Same as Above.
[7] MOZLEGAL, Land Law Regulation, 2004.
[8] PEUMM

and registration processes of DUAT and building permits should be considered. Furthermore, it is necessary to plan spatial urban development and land use plans at an early stage to allow for local governments to clearly designate and reserve areas for future infrastructure developments to mitigate clashes with informal inhabitants.

C.4 Review of the Existing Plans

Various plans for urban development for the Maputo Metropolitan Region have been conducted in the past few decades. Summarized below are the types of plans utilized in urban planning, development, and land use planning:

1. **Detailed Plan:** a land use planning tool that defines in detail the type of occupancy of any specific area of the town center, establishing the design of urban space, providing land uses and conditions of buildings, the layout of roads, the characteristics of infrastructure networks and services to new areas or existing areas, characterizing the facades of buildings and arrangement of open spaces;
2. **General Plan and Partial Urbanization Plan:** a planning tool determining the structure and qualify the urban territory, taking into account the balance between different uses and urban functions, defining the transport networks, communications, energy, sanitation, and social services, with special attention to areas of spontaneous occupation as a basis for socio-spatial development of the plan; and
3. **Urban Structure Plan:** planning instrument establishing the spatial organization of the whole territory of the municipality or village, the parameters and standards for land use, taking into account the current occupancy, infrastructure, existing social facilities and its integration in the regional spatial structure[9].

The Urban Structure Plan for Maputo Municipality (PEUMM) and Matola City (PEUCM) are considered urban structure plans, while ProMaputo involves a set of Partial Urbanization Plans for various bairros and districts of Maputo Municipality.

C.4.1 Urban Structure Plan for Maputo Municipality (PEUMM) 2008

(1) Objectives of the PEUMM

The specific objectives of PEUMM are summarized as follows[10]:

1. The rehabilitation of slums, and progressive integration of such informal settlements into the formal urban fabric through the expansion of public services, development of infrastructure and social facilities, and the demarcation and use of each block;
2. The establishment and reservation of space for infrastructure and connection to the greater region by improving links and accessibility to the city;
3. The assignment urban land use classes and categories to all portions of the urban territory;
4. The provision of space for social and public services and facilities;
5. The recovery of public areas for social, leisure, and recreational facilities;
6. The rehabilitation and integration of areas for the production and practice of urban agriculture necessary for the survival of a high percentage of urban households;
7. Promotion of multi-functionality of the neighbourhoods and establishment of rules for residential densification and economic activity;

[9] PEUMM
[10] PEUMM

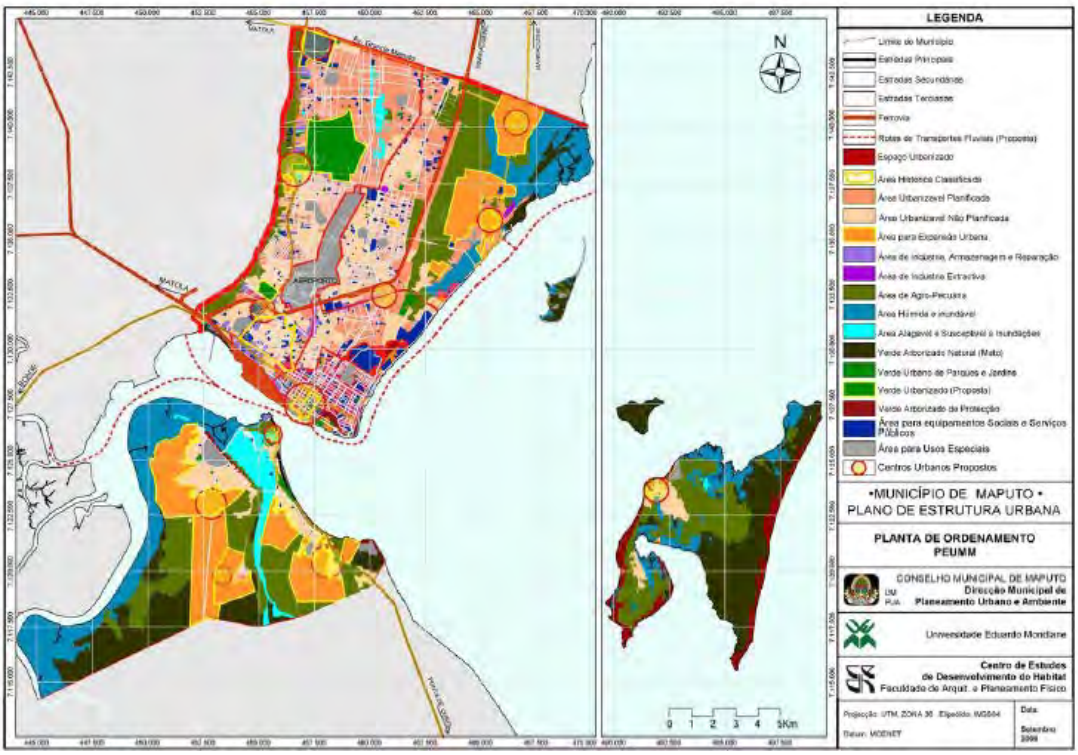
8. The promotion of the aesthetics of the city redevelopment with the creation of visual landmarks and improvement of social life related to the formal urban fabric;
9. The establishment of alternative absorption measures to respond to population increases in the city; and
10. The projection of demands of water and energy required for the city in the future11.

Furthermore, the priorities of the PEUMM are as follows:

1. Reorder informal settlements;
2. Regain land for public and institutional uses;
3. Increase the density of occupation within the urban fabric to prevent disorderly occupation of urban land;
4. Reserve areas to restore and maintain ecological balance and environmental quality;
5. Establish necessary conditions for smooth traffic and mobility;
6. Promote the construction of social housing;
7. Promote the diversification of activities and urban functions; avoid suburbanization and spatial segregation of the disadvantages social strata; and
8. Reduce social inequalities and privileges in choosing sites for distribution of infrastructure networks.

(2) Proposed Urban Structural Plan

Figure C.6 shows the proposed urban structure plan for the development for Maputo Municipality.



Source: PEUMM

Figure C.6: Urban Structure Plan for Maputo City

[11] PEUMM

The key elements governing the Maputo Urban Structure Plan are as follows[12]:

1. The containment of urban sprawl of disordered, and informal settlements;
2. The strict definition of uses better suited for urban perimeters;
3. The establishment of protected areas, monitoring of environmental and surrounding landscape;
4. The reduction of harmful actions around sensitive areas;
5. The gradual satisfaction of appropriations in equipment for the entire land area;
6. The incorporation of urban spaces during programming;
7. The creation of green spaces of adequate size, then integrating preferably of low alluvial soil; and

(3) Mobility and Accessibility

In terms of Mobility and Accessibility, the plans included in the PEUMM are as follows[13]:

Phase 1:

1. Recovery Program of Public roads;
2. Improvements on Avenue Joaquim Chissano;
3. Improvements on Avenue Vladimir Lenin;
4. Improvements on National Highway No. ;
5. Intercity Bus Terminal Transport in the Zimpeto Neighbourhood;
6. Rehabilitation of Avenue Julius Nyerere;
7. The connection of Avenue FPLM and Avenue Angola;
8. Urban Traffic Management;
9. The Establishment of an Internal Circular Road Connecting the City;
10. Improvements in the Operation of Public Transportation Services; and
11. Maritime Passenger Transport (Ferry-boat).

Phase 2:

1. Access routes to Existing Residential Areas;
2. Construction of Designed Roads;
3. Location Areas for the Construction of Intermodal Transport Terminals;
4. Terminals for intermodal transfer from Rail to Road;
5. Intermodal Stations for Rail, Road and Air;
6. Intermodal Terminal for Regional Road Transport and Urban roads;
7. Location of Areas for Supply Pumps for Fuel and Gas;
8. Special Public Transport Stops; and
9. Access to Areas of Urban Expansion such as Ka Tembe, Costa do Sol, Zimpeto, and Mapulene.

Phase 3: Future Road Infrastructure:

1. Bridge to Ka Tembe;
2. Construction of a connection between the Route of the Marginal Highway and Avenue C. A. Santos;
3. The Introduction of Trolley buses;
4. Light Rail; and
5. Connection between Maputo and Matola via the River.

[12] PEUMM
[13] PEUMM

C.4.2 Urban Structure Plan for Matola City (PEUCM) 2010

(1) Objectives of the PEUMM

Specific objectives of PEUCM completed in 2010 are identified as follows[14]:

1. Making Matola City a center of excellence that generates wealth;
2. To improve accessibility, mobility and the system of public transport;
3. Organize the distribution of functions within a rational and coherent matter;
4. Define residential areas that should be increased in density;
5. Define spaces for industry, public utility, and sports;
6. Establish rules for sufficient percentage of urban space to urban green areas (parks, gardens and trees along the roads); and
7. Establish rules to allow for transformations in already built areas.

(2) Proposed Urban Structural Plan

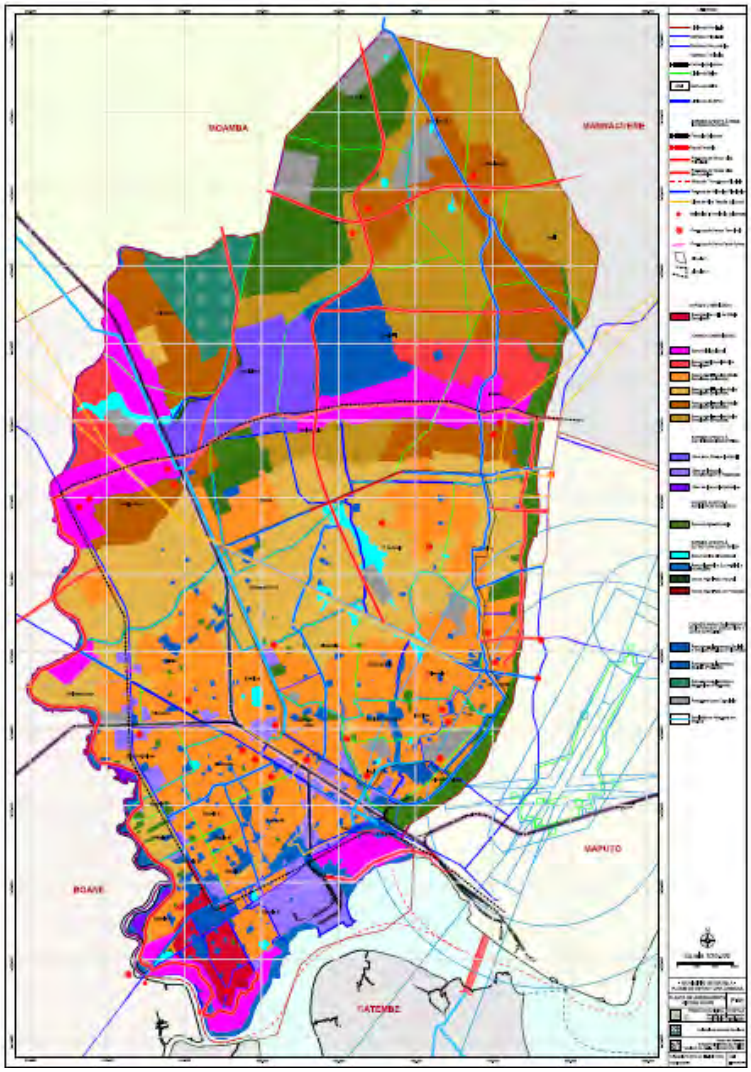
Through the process of the development of the urban structural plan and the public hearing, the following were expressed as development visions for Matola[15]:

1. Matola as a multi-purpose metropolitan city;
2. Matola as a residential area of excellence;
3. Matola as a center for sports tourism and culture; and
4. Matola as an agricultural reserve of the metropolitan area.

The objectives governing the development of the Matola Urban Structure Plan shown in Figure C.7, similar to the PEUMM, are as follows[16]:

1. The containment of urban sprawl of disordered, and informal settlements;
2. The strict definition of uses better suited for urban perimeters;
3. The establishment of protected areas, monitoring of environmental and surrounding landscape;
4. The reduction of harmful actions around sensitive areas;
5. The gradual satisfaction of appropriations in equipment for the entire land area;
6. incorporating urban spaces during its programming;
7. The creation of green spaces of adequate size, then integrating preferably of low alluvial soil

[14] PEUCM
[15] PEUCM
[16] PEUCM



Source: PEUCM

Figure C.7: Urban Structure Plan for Matola

(3) Mobility and Accessibility

The key issues regarding mobility and accessibility in Matola discussed in PEUCM are as follows[17]:

1. Weak linkages between the various modes of transport leading to a transport system with weak mobility and accessibility;
2. Unplanned bus stops and terminals for road transport with lack of security for passengers and leading to long wait times at bus stops, which effects other traffic on the road;
3. Low mobility within the city due to the degradation of roads as well as the conflict between heavy vehicle traffic and passenger traffic;
4. Traffic congestion due to the Maputo–Matola commute;
5. Poor accessibility to neighbourhoods north of the city mainly by lack of roads and pathways; and
6. Poor Urban Planning and Control urban.

[17] PEUCM

Given the issues stated above, the following linkages are proposed in the PEUCM.

The establishment of new access between Matola and Maputo is a high priority.

1. New avenues for access to the city of Matola from the Maputo City:
2. Toll-T3 N1 (Extension of Lourdes Mutola)

Secondly, the intra-urban connection within the city, especially the northern area, should be prioritized:

1. Connecting Bedene – Muhalaze – Golhoza and Mucatine;
2. Connecting Mathemele – Matola Gare – Drive-in;
3. The road link Matola Gare – Tsala – Witbank;
4. Connecting T3 – Boquisso;
5. Connecting Tchumene – Boane;
6. Connecting Mali – Muhalazi;
7. Connecting Matola Gare – Umatibjana;
8. Connecting Boquisso – Golhoza;
9. Connecting Nkobe – St. Damasus; and
10. Connecting N4 Toll – Freedom – Machava – T3 – Benfica.

Other interventions to alleviate congestion and improve access include:

1. Relieve traffic congestion on the Avenues of Industries especially in rush hours;
2. Extend the road access to Nkobe and regulate freight traffic; and
3. Construction of a Bridge area in Malhampsene in EN4[18].

C.4.3 Maputo Municipal Development Program (ProMaputo)

The objective of the 10 year municipal development program – Maputo Municipal Development Program (ProMaputo) is to "Strengthen the Maputo City Council's institutional and financial capacity to support achievement of long-term service delivery goals, and to implement selected priority investments". ProMaputo's primary focus is on institutional reform and capacity building for city administration and then on large-scale investment in infrastructure and services once the foundation is laid[19].

The project is designed under the following concept:

1. The Vision: Maputo, as a prosperous, attractive, clean, secure, and united city
2. The Mission: Enhance the coverage and quality of municipal services offered to residents of Maputo by strengthening institutional and financial capacity
3. Program components to ensure the operational implementation of the Mission:
   (A) Components A and B to ensure human resources, management capacity and financial resources for governance and service delivery to citizens;
   (B) Component C focused on planning and service delivery improvements.

Under the revised project development objectives, the MMDP's three components are as follows, of which the urban planning component is summarized in Table C.1[20].

[18] PEUCM
[19] World Bank, Implementation Completion and Results Report for the Pro Maputo: The Maputo Municipal Development Program
[20] Note: Cells highlighted in grey suggests components directly pertaining to Land Use and Urban Planning.

1. Component A: Institutional reform and municipal governance
2. Component B: Municipal Finance
3. Component C: Planning and service delivery improvements[21]

Table C.1: ProMaputo Phase 1 Component C: Planning, Infrastructure Rehabilitation and Service Delivery Improvements

#	Results	Assessment
1	Baixa and Marginal Urbanization Plan	Not Completed
2	Zimpeto Urbanization Plan	Satisfactory
3	Magoanine A, B and C Urbanization Plan	Satisfactory
4	Urbanization Plan for Laulane, Ferroviario, 3 de Fevereiro, Mahotas	Satisfactory
5	Urbanization Plan for Costa do Sol	Not Completed
6	Albazine Urbanization Plan	Satisfactory
7	Urban Structure Plan	Satisfactory
8	Municipal Geographic Information System (GIS) System Development	Satisfactory
9	Municipal Geographic Information System (GIS) Hardware and Software	Satisfactory
10	Environmental Impact Assessment (EIA) for Michafutene/Marracuene Cemetery	Satisfactory
11	Environmental Impact Assessment (EIA) for Julius Nyere Av.	Satisfactory
12	Av Sebastiao Mabote Rehabilitation	Satisfactory
13	Increase Street Light Network	Satisfactory
14	Rehabilitation of paved and unpaved road	Satisfactory
15	Cemetery Construction	Moderately Satisfactory
16	Solid Waste Collection in Urban Areas	Satisfactory
17	Solid Waste Collection in suburban areas and markets	Satisfactory
18	Primary Waste Collection	Satisfactory
19	Operation of Municipal Dump Site Hulene	Moderately Satisfactory

In the context of land use and urban planning, it is important to realize the Partial Urbanization Plans (PPUs) of the northern districts of Maputo. The main objectives of the PPUs are as follows:

1. Adjustment and/or allocation of DUAT's, including regularization of existing buildings; and
2. Improvement in areas of occupation which are spontaneous and disordered.

C.4.4 Marracuene and Boane Plan

As explained in Technical Report C.2.(3) and C.2.(4), the planning departments of the Boane and Marracuene do not have the same execution capacity compared to Maputo Municipality and Matola City, and currently do not have an updated land use plan. Due to the lack of a completed district land use plan, for the purpose of this project, the CENACARTA land use map combined with Spot 5 satellite imageries interpretation and Google images have been used for Boane and Marracuene.

Boane and Marracuene are currently in the process of finalizing the plans in 2013. The District of Marracuene is currently preparing the district land use plan with the technical support of a Maputo-based private consulting company (DHV). The authorities of Boane are currently conducting a study with the support from the Ministry of Environmental Affairs.

[21] World Bank, Implementation Completion and Results Report for the Pro Maputo: The Maputo Municipal Development Program

C.5 Major Findings

Common key issues for urban development in Greater Maputo that are addressed in PEUMM, PEUCM, ProMaputo, individual consultancy meetings with Boane and Marracuene SDPI, as well as urban planning technical working groups can be summarized in Table C.2.

Table C.2: Key Urban Planning Issues and Recommendations

Issues	Recommendations
The strict definition of better land use suited for urban perimeters, including areas for ecological protection, urban infrastructure including social and public utilities and services, green space and recreation, etc.	• Development of Urban Structure Plan for Marracuene and Boane • Using ProMaputo as a precedent, Development of Partial Urbanization Plans for key areas of Matola, Marracuene, and Boane • Strengthening of the process and capacity of the Cadastre Departments in order for smooth processing of DUATs
The containment of urban sprawl of disordered and informal settlements, and gradual integration to the formal urban fabric with appropriate urban infrastructure	• Same as above
Weak linkages in terms of mobility and accessibility	• Identify areas with weak linkages in terms of mobility and accessibility • Identify new growth areas requiring access • Establish a holistic master plan for Greater Maputo with projects strengthening both inter-urban and intra-urban linkages

Source: JICA Project Team

Many of the issues and recommendations addressed in Table C.3, are not only a result of top-down approach, but are an outcome of extensive interaction with local communities. The results of the 2010 Maputo Citizens Report Card suggest that key urban issues shared at the individual level in line with those identified in PEUMM, PEUCM, and ProMaputo.

Table C.3: Key Urban Issues Indicated in the 2010 Maputo Citizens Report Card

	KaMpfumu	Nhlamankulu	KaMaxkeni	KaMavota	KaMubukwana	KaTembe	KaNyaka
1	Solid Waste Collection	Neighbourhood Security	Water Provision	Solid Waste Collection	Solid Waste Collection	Water Provision	Electricity Provision
2	Accessibility	Accessibility	Neighbourhood Security	Water Provision	Neighbourhood Cleanliness	Accessibility	Water Provision
3	Neighbourhood Cleanliness	Water Provision	Health	Neighbourhood Security	Water Provision	Public Transport	Public Transport
4	Traffic Management	Solid Waste Collection	Solid Waste Collection	Accessibility	Accessibility	Electricity Provision	Accessibility
5	Drainage	Neighbourhood Cleanliness	Accessibility	Health	Electricity Provision	Health	Neighbourhood Cleanliness
6	Health	Drainage	Schools	Public Transport	Neighbourhood Security	Solid Waste Collection	Solid Waste Collection
7	Markets	Health	Neighbourhood Cleanliness	Electricity Provision	Public Transport	Agriculture	Markets
8	Public Transport	Drainage	Electricity Provision	Schools	Health	Schools	Agriculture
9	Parks	Markets	Public Transport	Neighbourhood Cleanliness	Schools	Neighbourhood Cleanliness	Health
10	Municipal Police	Public Transport	Markets	Markets	Fire Fighting	Markets	Schools

Source: 2010 Maputo Citizens Report Card

Technical Report D

Development Framework

Contents

Figures

Tables

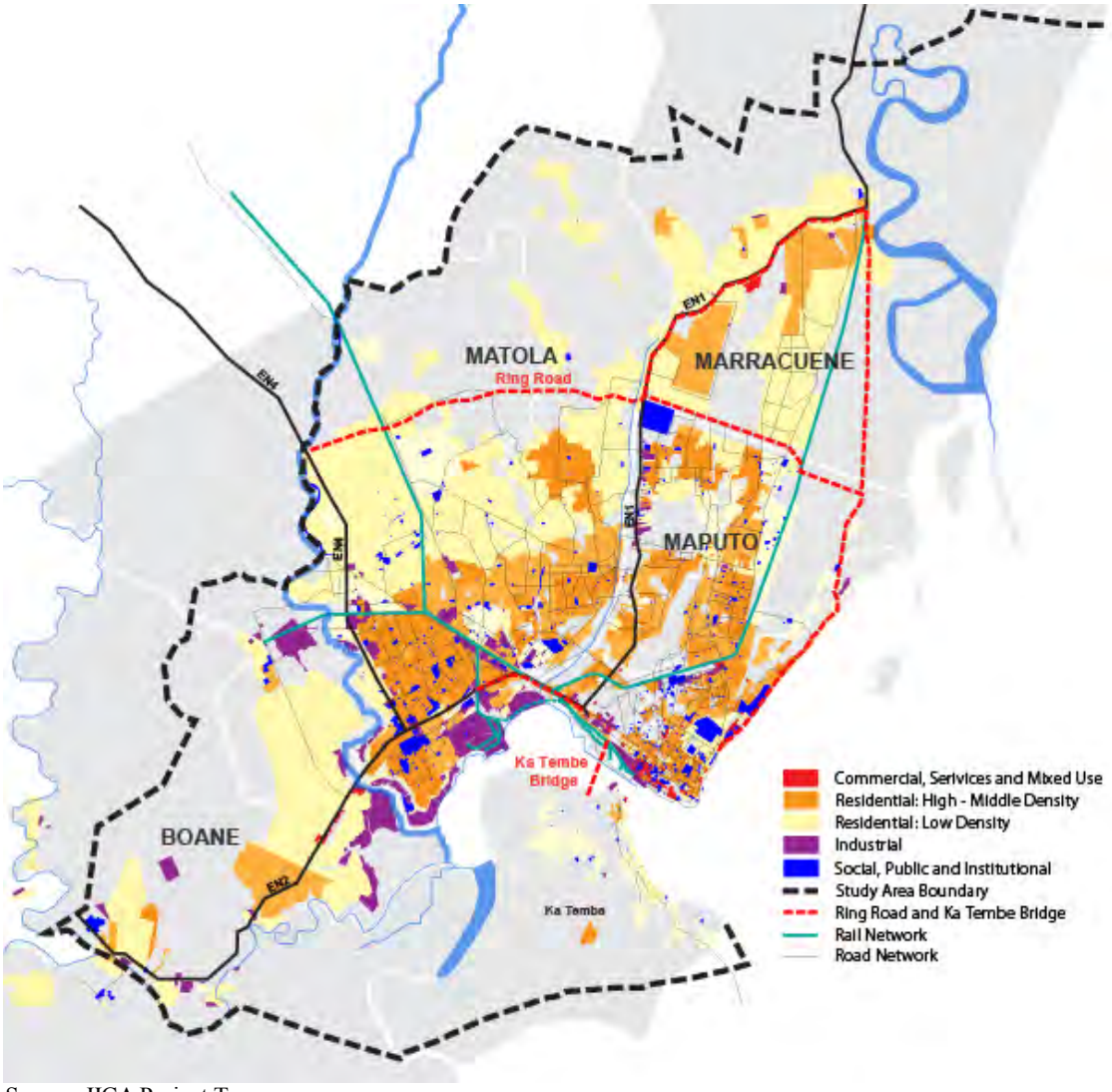
Technical Report D Development Framework

D.1 Introduction

This section examines urban planning and land use trends to establish the urban development scenarios for the transport demand forecast modeling.

D.2 Existing Land Use and Development Trends

Figure D.1 shows the consolidated existing land use pattern compiled by the JICA Project Team based on existing structure plans, geographic information system (GIS) remote sensing, satellite imagery, and interviews with urban planning officials. Much of the existing land use map for Maputo Municipality and Matola City is based on the *Plano de Estrutura Urbana do Município de Maputo* (PEUMM – Maputo Municipality Urban Structure Plan 2008) and the *Plano de Estrutura Urbana da Cidade da Matola* (PEUCM – Matola City Urban Structure Plan 2010). The maps have been updated by overlaying satellite imagery and information from interviews to track developments in recent years. Although Boane City and Marracuene District are developing an existing land use plan, due to the schedule of this study, existing land use in these two districts were compiled based on GIS remote sensing, satellite imagery, and information from interviews. Details of the existing land use pattern are further discussed in Technical Report A.



Source: JICA Project Team

Figure D.1: Existing Land Use

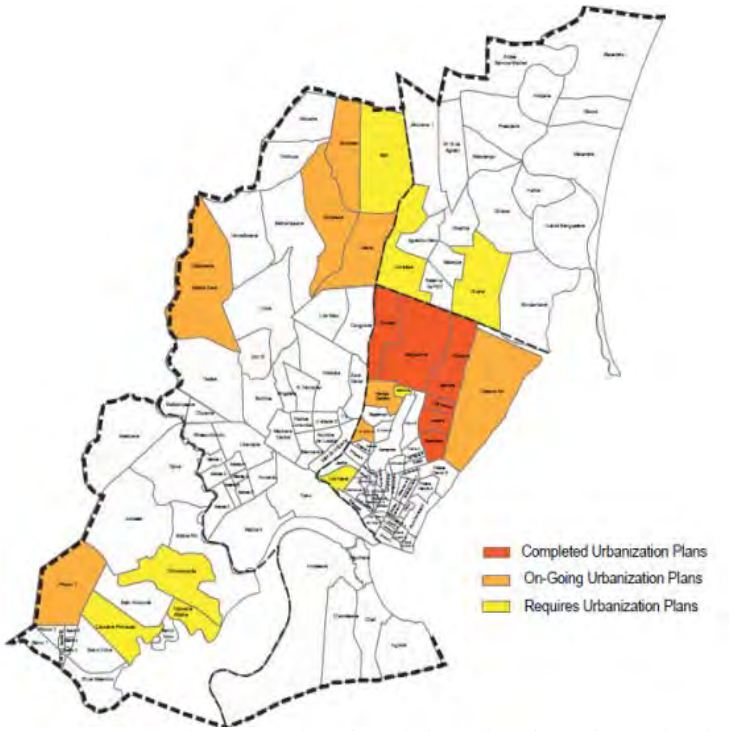
Based on the land use pattern shown above, the 2011 socio-economic indicators (such as population, number of workers, and number of students) were spatially distributed to the C-zone level for the purpose of the transport modeling and analysis. Table D.1 shows the area in hectares, 2012 population, and average density (persons/hectares) by municipality/district.

Table D.1: Current Area, Night Time Population and Average Density by Municipality/District

Region	Area (HA)	2012 Population	Average Density (persons/HA)
Maputo	26,961	1,188,612	44
Matola	38,079	827,475	22
Marracuene	30,490	88,309	3
Boane	25,238	64,698	3
TOTAL	120,767	2,169,094	18
Highest Density Bairro (Maputo - Maxaquene B)	105	29,944	284

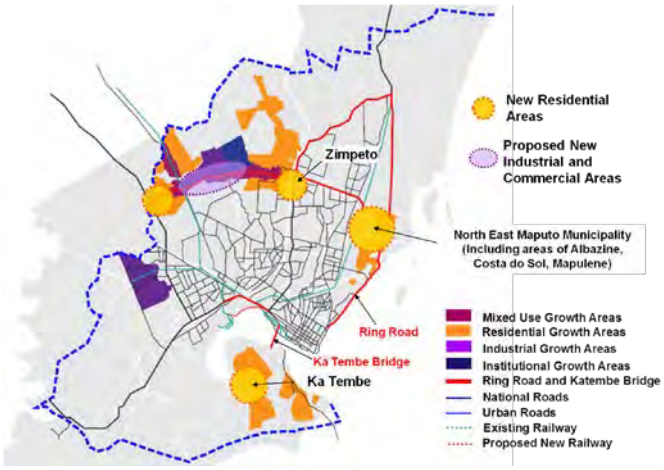
Source: JICA Project Team

Based on information collected from existing urban structure plans and interviews with stakeholders including planning officers of the municipalities and districts, national government agencies, donors, developers, and consultants, the JICA Project Team identified areas of urbanization plans (Figure D.2), growth centers (Figure D.3), and committed development projects (Table D.2) in Greater Maputo.



Source: JICA Project Team based on information from the National Institute of Statistics (INE) and interviews with Municipality, District, and National Government Agencies, as well as with consultants, in June 2012

Figure D.2: Areas for Urbanization Plans



Source: JICA Project Team based on PEUMM, PEUCM, and interviews with Municipality, District, National Government Agencies, as well as with consultants, in June 2012

Figure D.3: Growth Centers

Table D.2: Planned and Committed Development Projects

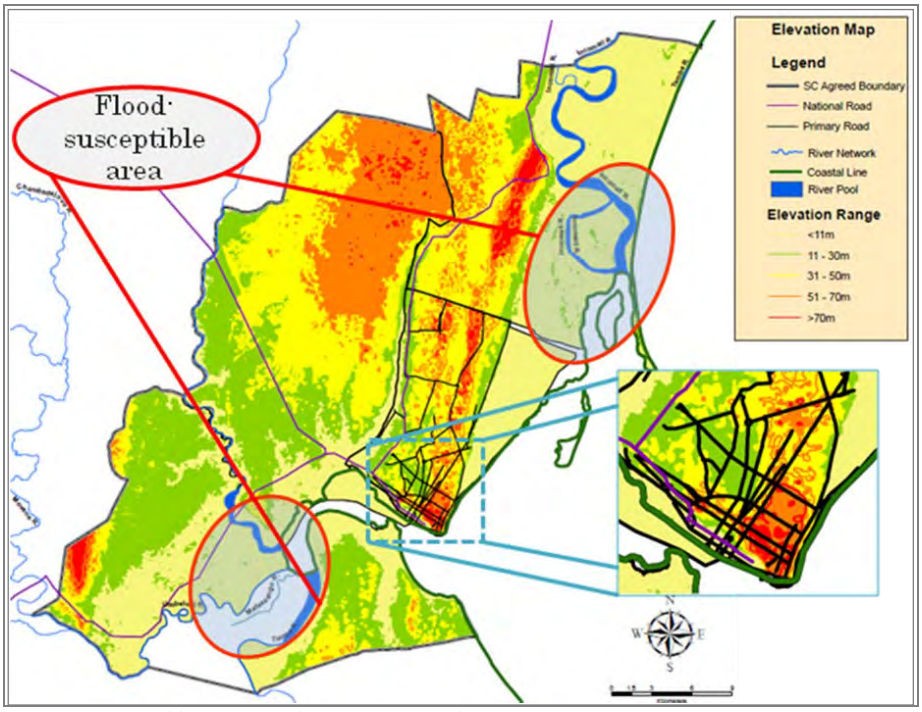
Name	Municipality/ District	No. of Households Planned (Units)	Size (ha)	Expected Budget	Status	Developer/ Company
Dream Town Intaka	Matola City	5,000	300	MZM 12 billion (about USD 444 million equivalent)	Under Constructio n	Henan Gouji Industry and Development (China)
Zimtava	Marracuene District	Not yet determined	200	Not Available	Under Discussion	(Spanish Developer)
Possuane (Low Cost Housing)	Marracuene District	1,500	400	Not Available	Under Discussion	
Marracuene Land Use Plan	Marracuene District	–	–	–	Under Progress	DHV
Boane Land Use Plan	Boane City				Under Progress	
Piccoco 2	Boane City	8,000	400	Not Available	Under Discussion	Gamont Development (South Africa)
Mulotane (Low Cost Housing)	Boane City	Not Available	Not Available	Funding Approved	Under Discussion	(Portuguese-French Developer)
KaTembe (Within Maputo Sul/ Betar Plan)	Maputo Municipality	Not Available	200–300	–	Under Discussion	–
Cidadela de Matola Project	Matola City	Mixed Use (Shopping Center, hotel, etc.)	46,000 m^2	Public Investment Corporation (South African funded) will invest USD 200 million	Under Discussion	Consortium of SIF (Mozambique) and McCormick Property Development Company (South Africa)

Source: JICA Project Team based on Interviews with Municipality, District, and National Government Agencies, as well as with consultants, in June 2012

D.3 Physical Constraints for Urbanization – Natural Environment

D.3.1 Flood Susceptibility

Identifying physical constraints for urbanization are further essential to urban and land use planning. During the project, two flood-susceptible areas were identified (Figure D.4). Since these areas have high risks of being flooded due to the geographic condition and low natural drainage, the development in these areas should be avoided or carefully planned.



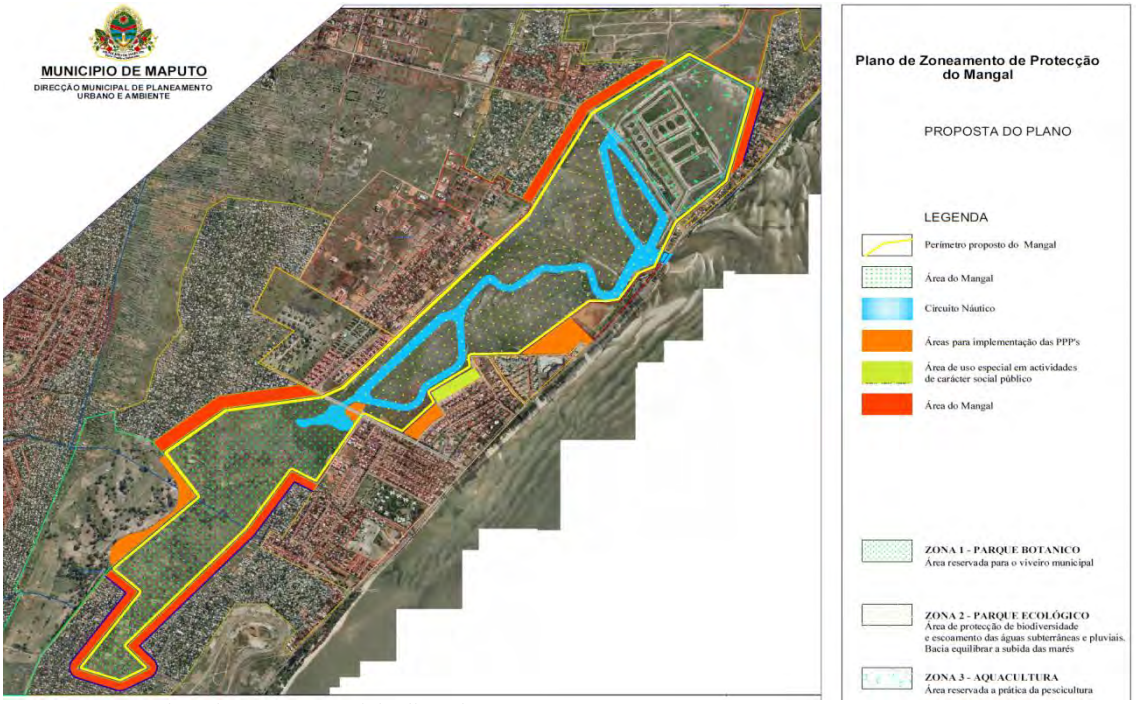
Source: Prepared by JICA Project Team (Based on ASTER DEM 90m)

Figure D.4: Topographical Map of Greater Maputo

D.3.2 Coastal Wetland (Mangroves)

Along the east 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.[1] 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 D.5.

[1] Zoning and Protection Study of Costa do Sol Mangrove/Wetland Final Report, 2011

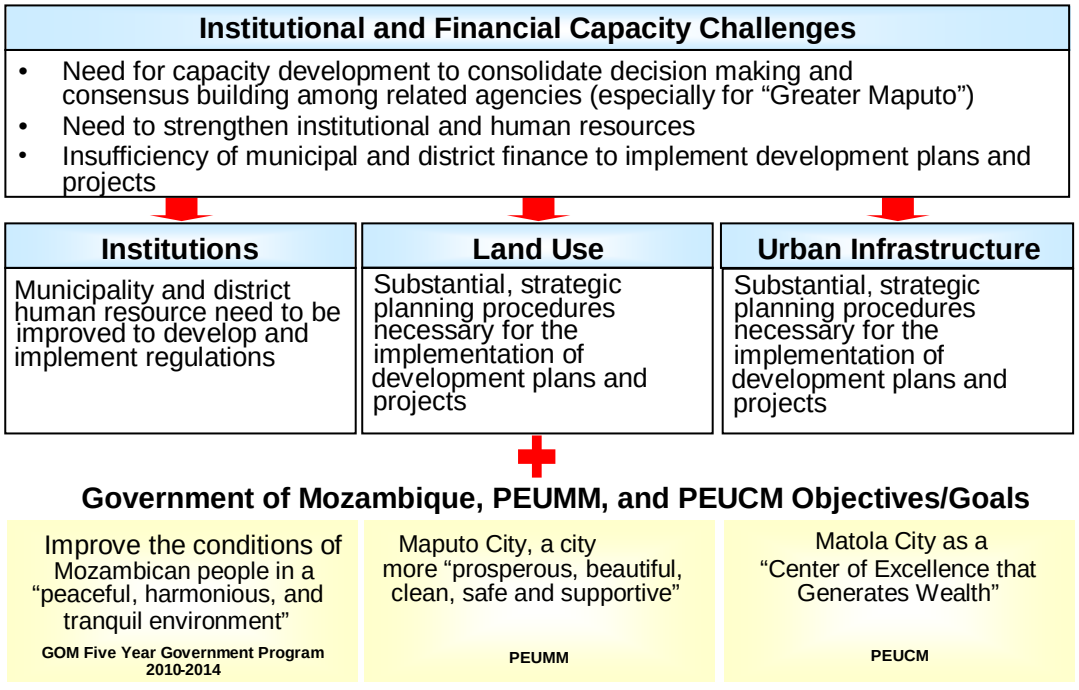


Source: Depart of Environment, Municipality of Maputo

Figure D.5: Costa do Sol Mangrove Conservation Area

D.4 Urban Development Visions, Goals, and Strategies

Through working groups and individual consultancy meetings with socio-economic, environmental, and urban planning officials and consultants, urban planning and development challenges in Greater Maputo were identified by stakeholders as summarized in Figure D.6.



Source: JICA Project Team

Figure D.6: Urban Planning and Development Challenges

Based on existing objectives and goals from the Government of Mozambique Five Year Government Program, PEUMM, and PEUCM, 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*"; and
Vision 3: Greater Maputo as a "*Dynamic and Vibrant Capital of Mozambique*".

The three potential urban development vision statements were examined through a Strategic Environmental Assessment (SEA) process as explained in Technical Report D.5, and the selected development vision statement is summarized in Figure D.7.

Urban Development Vision:

Greater Maputo as a "Socially and Environmentally Sustainable International Gateway Capital"

The Urban Development Vision in Detail:

Socially Sustainable Capital	Environmentally Sustainable Capital	International Gateway Capital
• Socially inclusive urban structure and infrastructure accessible to all inhabitants (including low-income, foreigners, disabled, elders, and children) • Economically inclusive urban industrial structure for sustainable economic growth including employment generation and poverty reduction	• Urban Structure that allows for the protection of inhabitants from natural disasters and unhealthy living conditions • Protection and preservation of natural conditions (green space and coastal areas) for future generations • Environmentally sustainable urban infrastructure accessible to all inhabitants	• Maximize benefits of Maputo's position as the transit city with access to ports, industrial zones and regional markets • Conservation of historical and cultural heritage for enhanced urban character and identity • Socially and environmentally sustainable economic growth and development

Source: JICA Project Team

Figure D.7: Urban Development Vision for Greater Maputo

To achieve the urban development vision for Greater Maputo, the following development strategies were agreed upon.

D.4.1 Multiple-Core Urban Structure

Strategy:

1. Shift of functions from the central business district (CBD) to poly-centers to alleviate traffic congestion
2. Development of polycentric commercial and business districts to decentralize economic activity
3. Plan appropriate local urbanization plans and strictly implement land use and zoning regulations to ensure that new informal developments do not occur. Furthermore, strengthen coordination and communication between the private and public sector to ensure commercial and business development are aligned with urban plans. Conduct

public meetings to disseminate information of updated plans and on-going projects to enhance private sector and citizen participation and ownership. Formalization and densification of housing development around poly-centers and/or public transport axes to decrease the costs of urban infrastructure

Outputs:

1. Lower and affordable commuting costs
2. Decentralized services accessible to peri-urban inhabitants
3. Controlled and planned urban growth containing sprawl
4. Densified and compact land use leading to lower urban infrastructure costs

D.4.2 Sustainable Economic Development

Strategy:

1. Utilization of existing assets such as Maputo/Matola Ports, Maputo Economic Corridor, and Free Economic Zones (FEZs)
2. Strategic upgrading and provision of urban infrastructure to enhance private sector investments
3. Diversification of sustainable economic structure for employment generation

Outputs:

1. Economic diversification and decentralization allowing for more revenue and greater budget for investments in urban infrastructure
2. Investments in urban infrastructure that will lead to increased private sector investments and land values
3. Minimization of budget and capacity discrepancies of local governments

D.4.3 International Capital for Culture

Strategy:

1. Enhance tourism and commercial development through the utilization of historical and cultural assets
2. Protection and preservation of green spaces, coastal areas, and natural disaster zones
3. Provision of urban amenities for sports, recreation, and parks
4. Improvement of urban health, sanitation, and safety

Outputs:

1. Urban structure with harmonized cultural, historic, and new buildings and infrastructure
2. Clean, healthy, and safe urban environment
3. Inclusive urban structure for all, including elders, children, disabled, foreigners, and lower-income households

D.4.4 Approaches in Line with Missions from Existing Urban Structural Plans

As shown in Table D.3, the urban development vision for Greater Maputo and its four urban development approaches are aligned with PEUMM, PEUCM and Pro Maputo, which are discussed in detail in Technical Report C.

Table D.3: Approaches in Line with PEUMM, PEUCM, and Pro Maputo

		Towards a Multiple Core Structure	Center of Sustainable Industrial Development	Environmentally Friendly Public Transport System	International Capital for Culture
PEUMM					
1	Reordering of the informal settlements	Yes			Yes
2	Regain land for public and institutional uses	Yes			Yes
3	Increase density of occupation within the urban fabric to prevent disorderly occupation of urban land	Yes		Yes	Yes
4	Reserve areas to restore and maintain ecological balance and environmental quality	Yes	Yes	Yes	
5	Establish necessary conditions for smooth traffic and mobility	Yes		Yes	
6	Promote the construction of social housing	Yes			Yes
7	Promote the diversification of activities and urban functions; avoid suburbanization and spatial segregation of the disadvantages social strata	Yes		Yes	Yes
8	Reduce Social inequalities and privileges in choosing sites for distribution of infrastructure networks.	Yes	Yes	Yes	Yes
PEUCM					
1	Make Matola City a centre of excellence that generates wealth	Yes	Yes		Yes
2	Improve accessibility, mobility and the public transport system	Yes		Yes	Yes
3	Organize the distribution of functions within a rational and coherent matter	Yes		Yes	Yes
4	Define residential areas that should be higher density	Yes			Yes
5	Define spaces for industry, public utility, and sports	Yes	Yes	Yes	Yes
6	Establish rules for sufficient percentage of urban space to urban green areas (parks, gardens and trees along the roads)	Yes			Yes
7	Establish rules to allow for transformations in already built areas	Yes			
Pro Maputo					
1	Accountability and public voice				Yes
2	Equitable access to key services	Yes		Yes	Yes
3	Broad Based Economic Growth	Yes	Yes	Yes	Yes

Source: PEUMM, PEUCM, Pro Maputo

D.5 SEA Consideration of Strategies

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*"

These statements were evaluated and compared in terms of the following viewpoints covering the environmental and social aspects.

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

The results of the evaluation are summarized in Table D.4. Vision 2 marked the highest score and therefore was selected as the development vision of the Greater Maputo Area.

Table D.4: 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

D.6 Urban Development Patterns (Existing Trend, Poly-Centric, Compact Corridor)

D.6.1 Context

Urban Development Scenarios for Greater Maputo dates back to 1985. The Structure Plan of 1985 for Maputo and Matola hypothesizes the following urban expansion pattern for the Maputo metropolitan area:

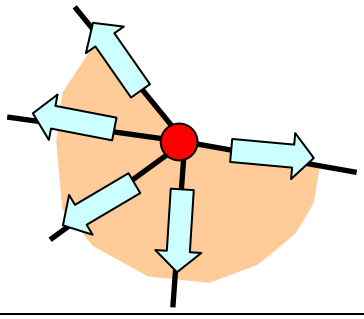
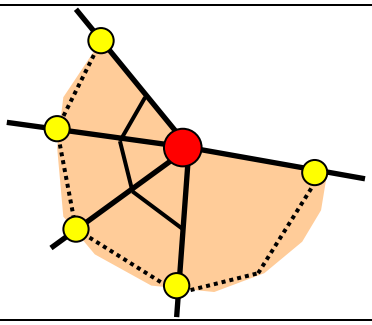
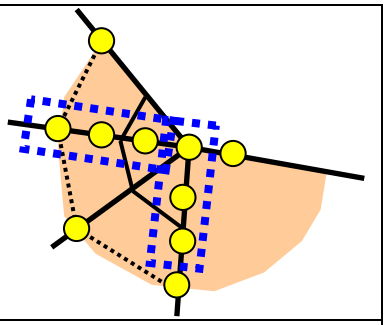
1. Uncontrolled Development (status quo);
2. Concentric Expansion;
3. Linear Expansion.

The 1985 plan addresses the importance of avoiding alternative 1 (uncontrolled development), and indicates that alternative 2 (concentric expansion) is unfeasible due to the lack of resources for its implementation. The plan suggests alternative 3 (Linear Expansion) as a feasible development pattern for the metropolitan area, with both long and short term benefits.[2]

A quarter of a century after the 1985 Structure Plan, Greater Maputo has grown significantly in population as well as socio-economically. However, the concern addressed in the 1985 Structure Plan has not yet been appropriately resolved. With the consideration of the socio-economic framework (Technical Report A), the current urban and land use conditions (Technical Report B), the plans and solutions explored in preceding structure plans (Technical Report C), the following section proposes Urban Development patterns and scenarios fit for the urban challenges of Greater Maputo.

D.6.2 Alternative Urban Development Scenarios

Three alternative urban development scenarios have been considered as summarized in Figure D.8.

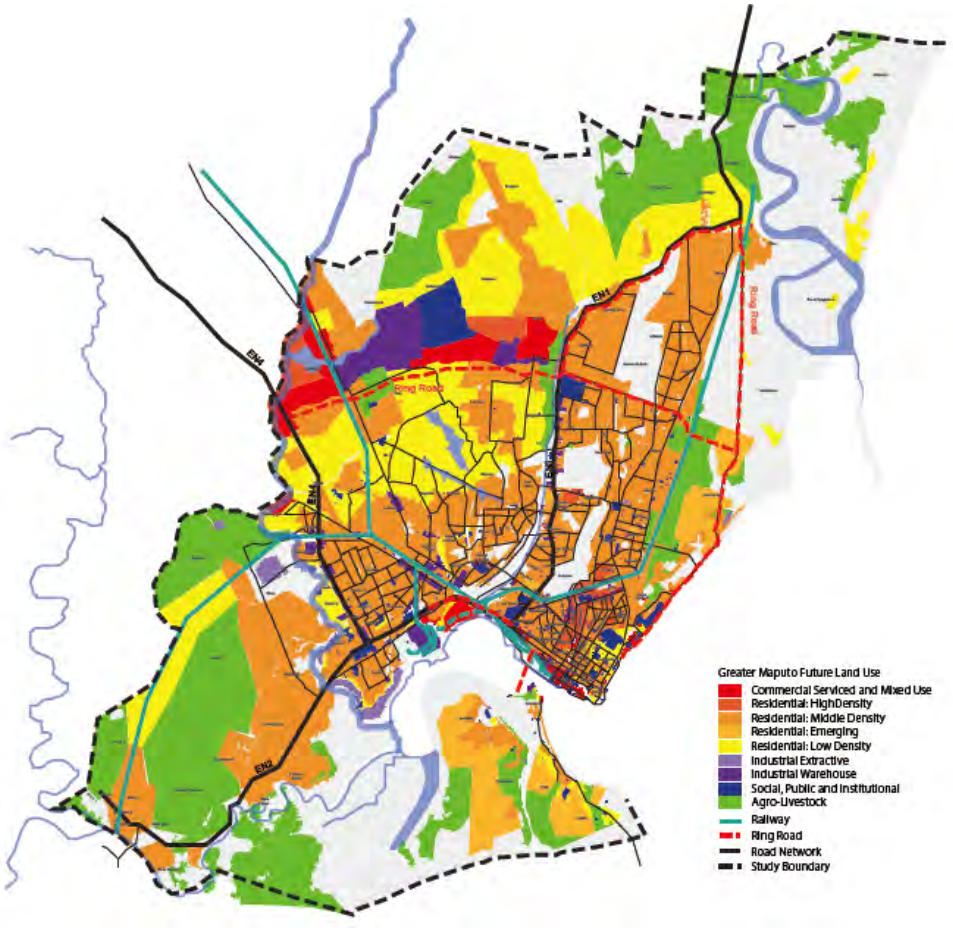
			
Scenario	A. Trend Growth: Monocentric Radial Development (Unplanned Growth)	B. Polycentric Satellite Center Development Pattern	C. Compact Corridor Development
Land Use Characteristics	Existing trend, uncontrolled urban sprawl, low-density development	Decentralized development, lower level of concentration in CBD	High-density development along mass transit corridors, decentralized population
Transport Network Characteristics	Automobile-oriented, buses and *chapas*, bus priority lanes	Automobiles and mass transit (BRT, buses, and *chapas*)	Mass transit (commuter rail, BRT, buses and *chapas*, or a combination of these, as feeders), relatively lower role for automobiles in urban area

Source: JICA Project Team

Figure D.8: Urban Development Scenarios for Greater Maputo 2035

As explained in Technical Report D.2, information on development trends from the structure plans of PEUMM and PEUCM, urbanization plans, growth centers and interviews regarding planned and committed projects have been collected, and a base (trend growth pattern or Scenario A) land use plan for 2035 has been created as shown in Figure D.9.

[2] PEUMM



Source: JICA Project Team

Figure D.9: Base Land Use Map of Greater Maputo 2035

Based on the land use pattern shown above, the 2035 trend growth (Scenario A) socio-economic indicators were spatially distributed to the C-zone level for the purpose of the transport modeling and analysis. Table D.5 shows the area, 2035 tend growth population and average density (persons/hectares) by municipality/district and its change from 2011.

Table D.5: 2035 Trend Growth Population, Average Density, and Change from 2011 by Municipality/District

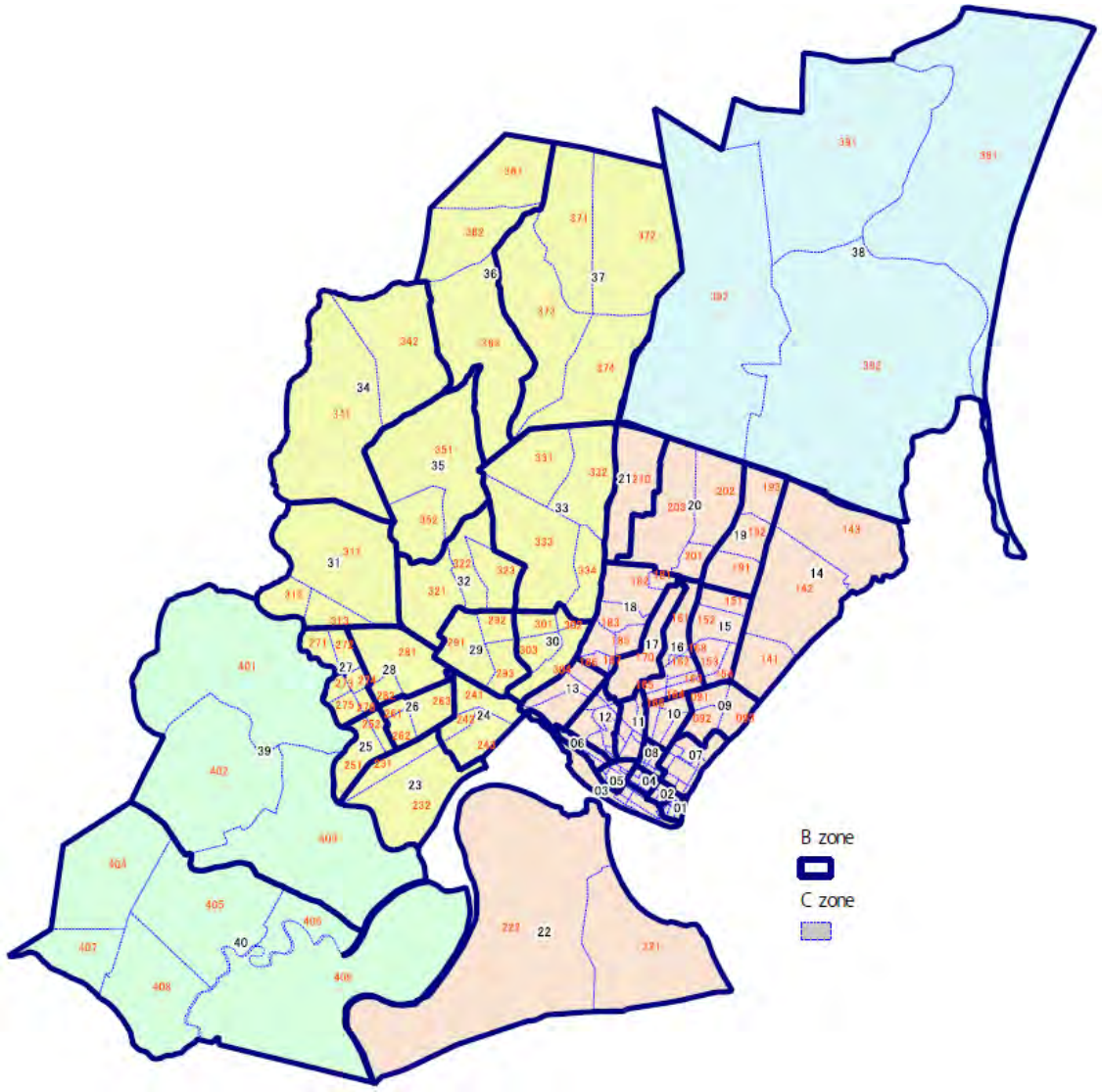
Region	Area (HA)	2011		2035 Scenario A (Trend Growth)		Change	
		Population	Avg. Density (persons/HA)	Population	Avg. Density (persons/HA)	Population	Avg. Density (persons/HA)
Maputo	26,961	1,188,612	44	1,553,836	58	365,224	14
Matola	38,079	827,475	22	1,692,815	44	865,340	23
Marracuene	30,490	88,309	3	265,691	9	177,382	6
Boane	25,238	64,698	3	184,257	7	119,559	5
TOTAL	120,767	2,169,094	18	3,696,599	31	1,527,505	13

Source: JICA Project Team

D.7 Distribution of Future Population, Employment and Enrollment

D.7.1 Methodology

Socio-economic indicators of future population, employment and enrollment are distributed at the C-zone level (shown in Figure D.10) for the purpose of the transport analysis.



Source: JICA Project Team

Figure D.10: C Zones for Distribution of Population, Employment, and Enrollment

The distribution of population, employment, and enrollment by C-zone for the three scenarios were derived as follows:

- Scenario A (Trend Growth) is considered the baseline for the distribution of socio-economic indicators. For each scenario, the Greater Maputo grand total of population, employment
- For Scenario B (Polycentric Satellite Center Development Pattern), areas considered as growth centers were identified at the C-zone level. Socio-economic indicators were

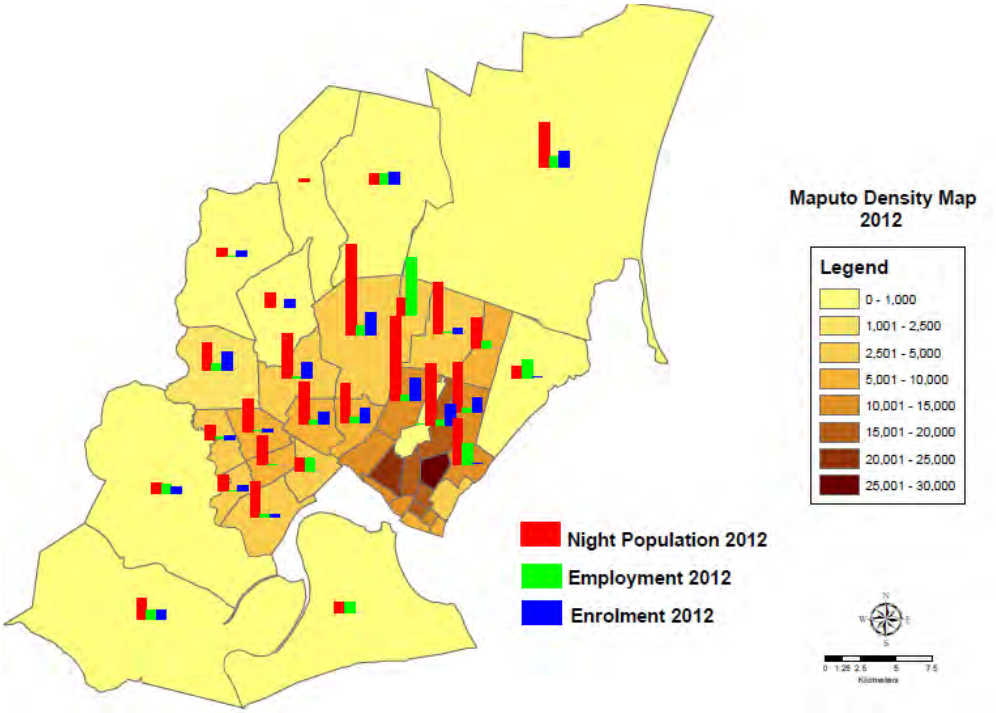
increased for growth center C-zones based on the predominant land use[3] and baseline socio-economic indicators in the zone. Similarly, socio-economic indicators were decreased for C-zones that were not considered growth center zones.

- For Scenario C (Compact Corridor Development), C-zones traversed by a railway and/or BRT route were identified. Socio-economic indicators were increased for C-zones traversed by a railway and/or BRT route based on the predominant land use and Scenario B socio-economic indicators in the zone. Similarly, socio-economic indicators were decreased for C-zones that were not traversed by a railway and/or BRT route

The socio-economic distributions of the current and future alternative scenarios are summarized graphically in Technical Report D.7.2 to Technical Report D.7.6. The numerical indicators are summarized in Technical Report D.7.7.

D.7.2 Current Socio-Economic Distribution

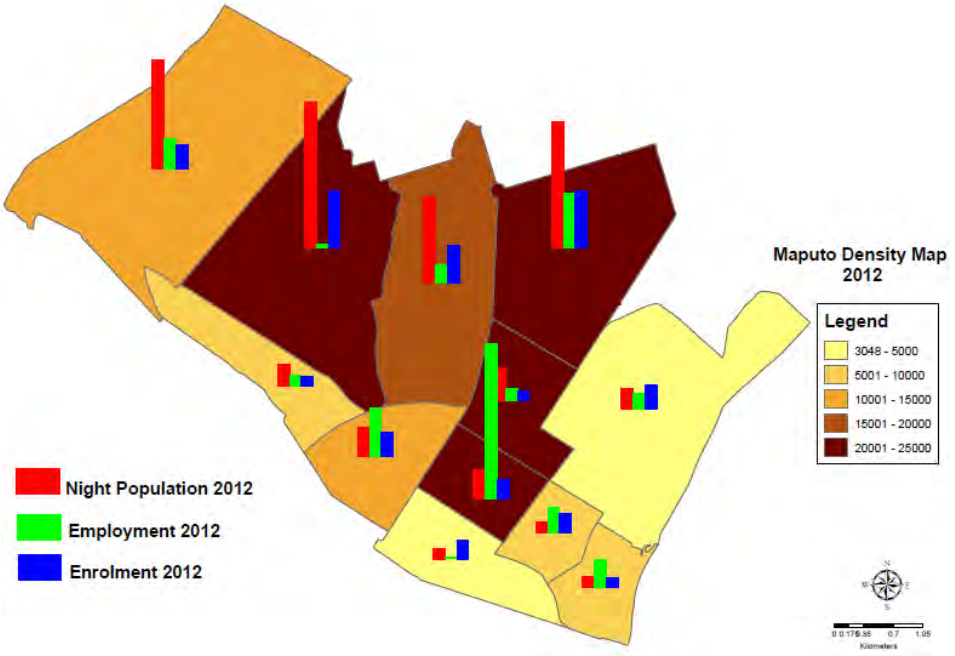
The current distribution of night time population, night time density, employment and enrollment is visually presented for Greater Maputo in Figure D.11 and for Maputo Municipality Central Business District (CBD) in Figure D.12.



Source: JICA Project Team

Figure D.11: Current Greater Maputo Socio-Economic Distribution

[3] For example, night time population was increased for C-zones with predominantly residential use, and employment was increased for C-zones with predominantly industrial use.

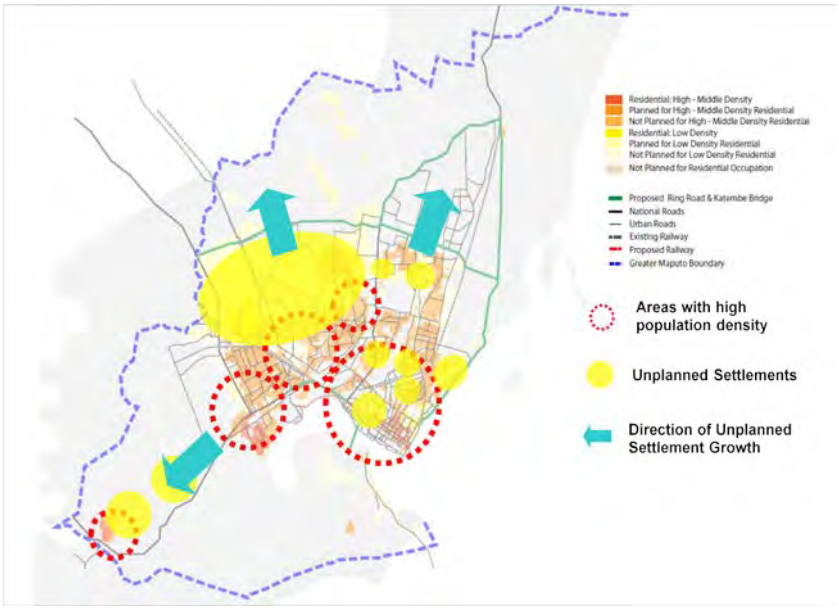


Source: JICA Project Team

Figure D.12: Current Maputo Municipality CBD Socio-Economic Distribution

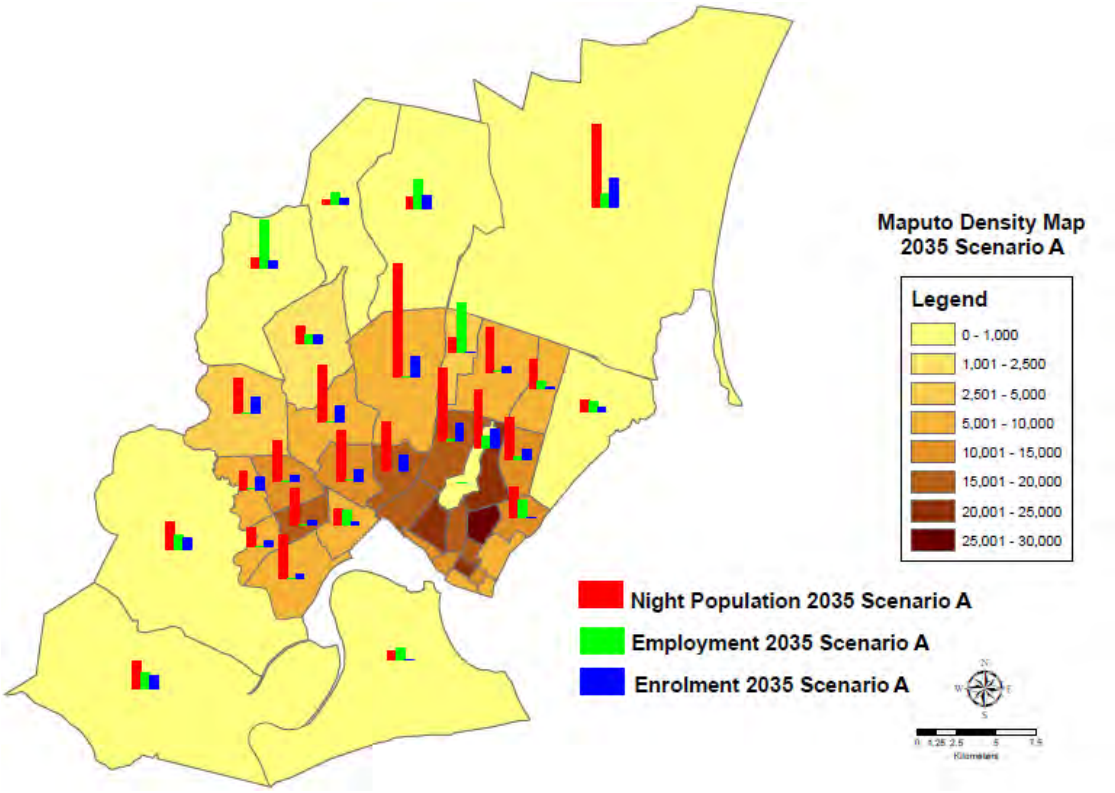
D.7.3 Scenario A: Trend Growth: Mono-centric Radial Development (Unplanned Growth)

Figure D.13 shows a conceptual diagram of trend growth. This can be considered unplanned growth that will lead to a mono-centric radial urban structure. The socio-economic distribution for the trend growth is summarized in Figure D.14 and Figure D.15.



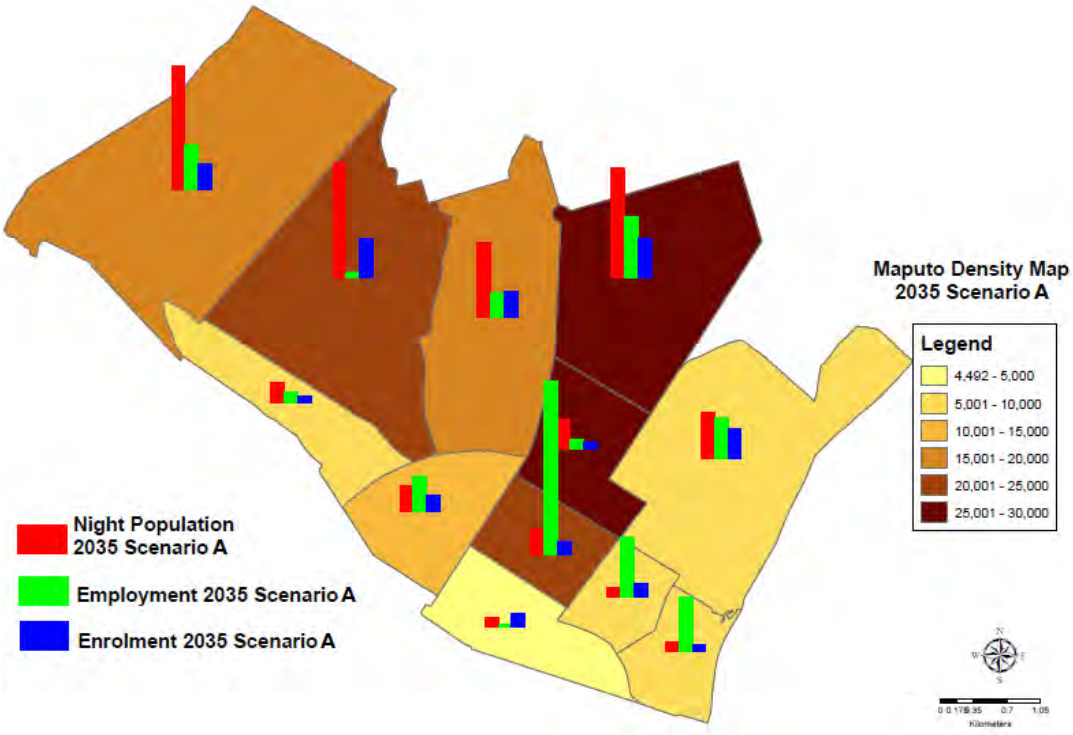
Source: JICA Project Team

Figure D.13: Trend Growth: Monocentric Radial Development Pattern



Source: JICA Project Team

Figure D.14: 2035 Scenario A Greater Maputo Socio-Economic Distribution



Source: JICA Project Team

Figure D.15: 2035 Scenario A Maputo Municipality CBD Socio-Economic Distribution

Preliminary Assessment

Scenario A (Mono-centric Radial Development – Unplanned Growth) is not a recommended urban development pattern for the following reasons.

In terms of urban planning:

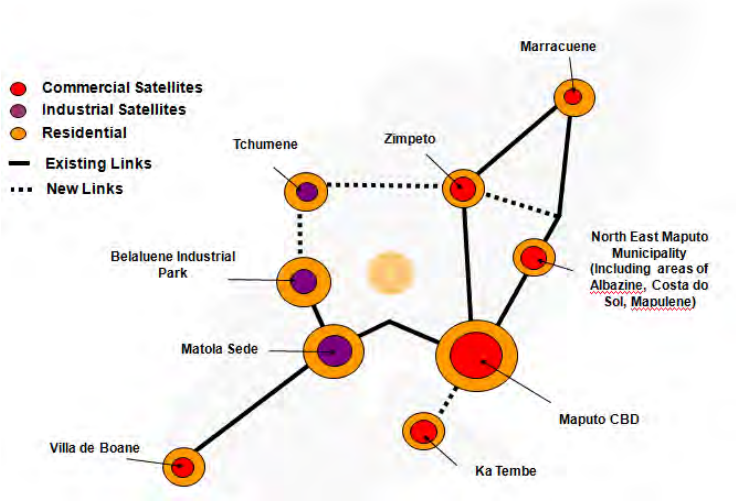
1. Unplanned urban growth often leads to the establishment of informal settlements without adequate access to urban infrastructure;
2. Once informal settlements emerge, the process of implementing urbanization plans and achieving necessary resettlements are challenging; and
3. Without a legally enforced urbanization plan, formalization of land use title (granting of DUAT) is challenging.

In terms of mobility and accessibility:

1. Unplanned new neighborhoods will emerge without adequate access to transport infrastructure, making accessibility to such neighborhoods extremely difficult; and
2. All commuter traffic from new neighborhoods will concentrate to the Maputo CBD, contributing to further traffic congestion and strains to the existing transport infrastructure.

D.7.4 Scenario B: Polycentric Satellite Center Development Pattern

Figure D.16 presents a conceptual diagram of polycentric satellite center development.



Source: JICA Project Team

Figure D.16: Polycentric Satellite Center Development Pattern

The potential for the poly-center satellites are summarized as follows.

Maputo CBD

Maputo CBD is by far the most densely population area in Greater Maputo. As of 2011, the District of Kampfumu alone had 3,079 registered enterprises employing approximately 80,760 workers, the largest in the area[4]. Much of the region's commercial activity is located in Maputo CBD, attracting workers as well as consumers from Matola, Marracuene, Boane. The high

[4] Refer to Appendix A

influx of population to the CBD during the day has lead to significant traffic congestion in the city during peak hours. The Poly-Centric Satellite Development Pattern attempts to decentralize the current mono-centric urban structure, which currently puts a significant strain on the existing transport infrastructure.

Matola Sede

Outside of Maputo Municipality, as a bedroom suburb of Maputo, Matola Sede has a high population density. Furthermore, as home to the Avenue of Industries and Matola Port, Matola Sede had 873 registered enterprises employing about 16,000 workers in 2011[5]. Its access to Maputo CBD via the EN2 also provides an advantage both in terms of commerce and residential development.

Belaluene

The Belaluene Industrial Park in Matola Rio of Boane, is home the largest industrial park in the country. Situated in Belaluene is the largest company in Mozambique, the Mozal Aluminum Smelter Factory, as well as a diverse portfolio of international investments. Its proximity to the Maputo Economic Corridor (including Maputo and Matola Port, EN4) and the proposed Ring Road, suggest it is strategically positioned for future growth and development.

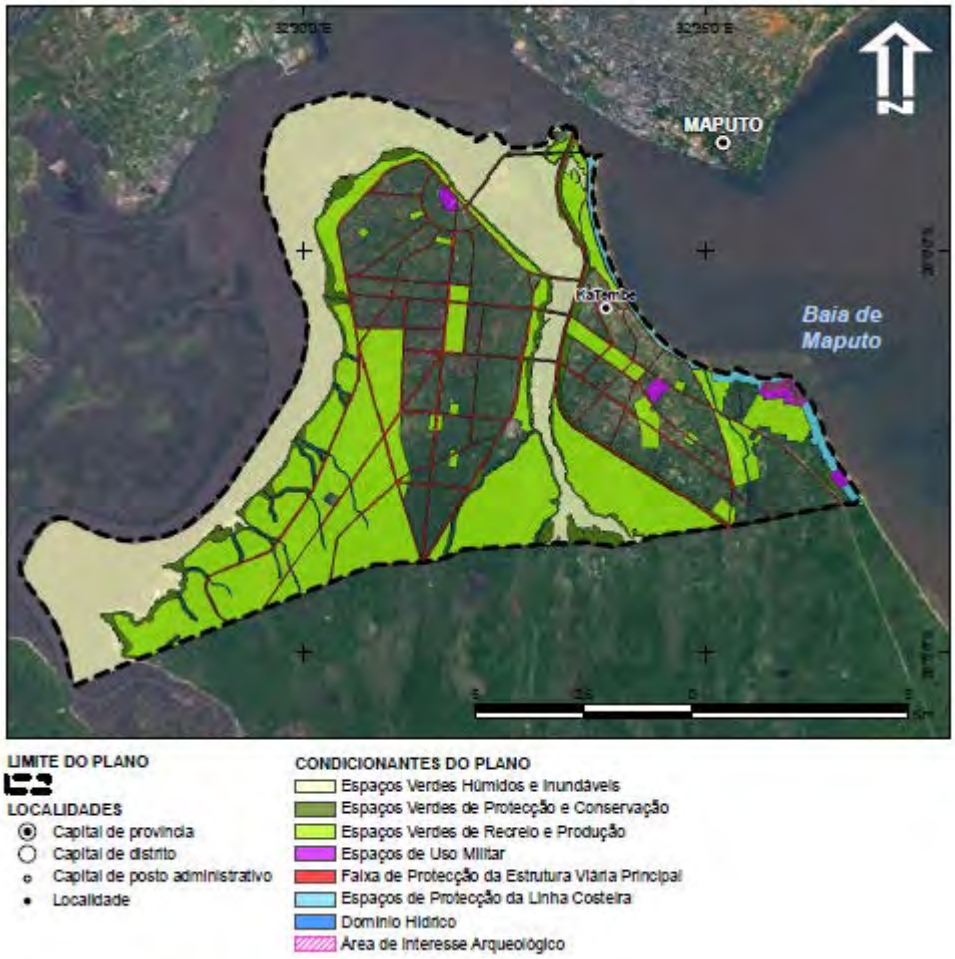
KaTembe

As identified in the PEUMM, with the proposed development of the bridge connecting Maputo CBD to KaTembe, the link between the two neighborhoods will be significantly enhanced stimulating residential development. A pre-feasibility on the environmental impact of the urbanization of the Ka Tembe Municipal District was completed in May 2012[6], and the initial public hearing was held on June 14, 2012[7]. Figure D.17 shows the development constraints from the Pre-Feasibility Study.

[5] Refer to Appendix A

[6] Beta Consultants/Betar Consultants: Estudo de Pre-Viabilidade Ambiental e Definicao do Ambito e dos Termos de Referencia do Estudo de Impacto Ambiental – Avaliacao de Impacto Ambiental do Plano Geral de urbanizacao do Distrito Municipal da KaTembe

[7] Based on attendance of Initial Public Hearing on June 14, 2012, and interview with Betar



Source: Avaliacao de Impacto Ambiental do Plano General de Urbanizacao do Distrito Municipal da Ka Tembe, 2012

Figure D.17: Constraints Plan of the General Urbanization Plan (PGU) of KaTembe

North East Maputo Municipality (Albazine and Costa do Sol)

New residential and urban development of Costa do Sol is identified in the PEUMM. A Partial Urbanization plan for Costa do Sol is currently on-going as part of the Pro Maputo financed by the World Bank.[8] New residential development of Mapulene is identified in the PEUMM. Furthermore, the completed Partial Urbanization Plan for Albazine (Plano Parcial de Urbanização do Bairro Albazine – PPUBA) conducted as part of Pro Maputo Phase I.

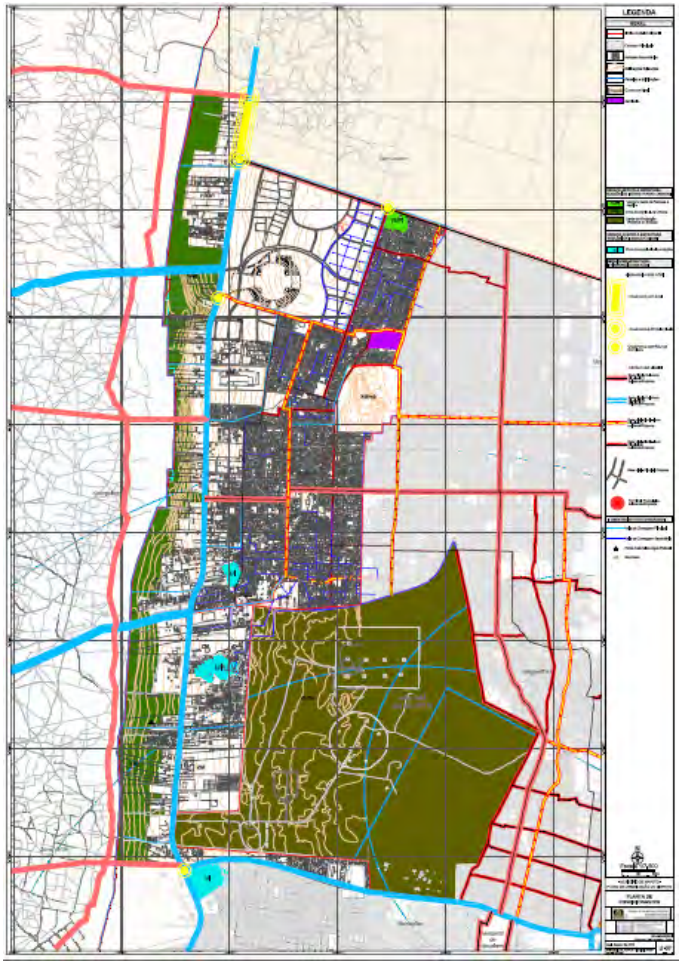
However, as stated in Technical Report D.3.2, the east coast of Greater Maputo Area is the low-lying wetland covered by mangroves and has been added to an ecological protection area in October 2012, hence development in this area must be handled with sensitivity.

Zimpeto

New residential development of Zimpeto is identified in the PEUMM. As shown in Figure D.18, the Zimpeto National Stadium, its adjacent Olympic village, and upgrading of the national roads in the area, completed in 2011 with funding from the Chinese Government as well as the market

[8] Based on Interview with Maputo Municipality Department of Urban Planning, June 26, 2012.

located in Zimpeto brings economic activity to the area, and further residential development in the area is anticipated. Zimpeto's access to the EN1 and the proposed ring road make it a strategic area for the development of an urban poly-center.

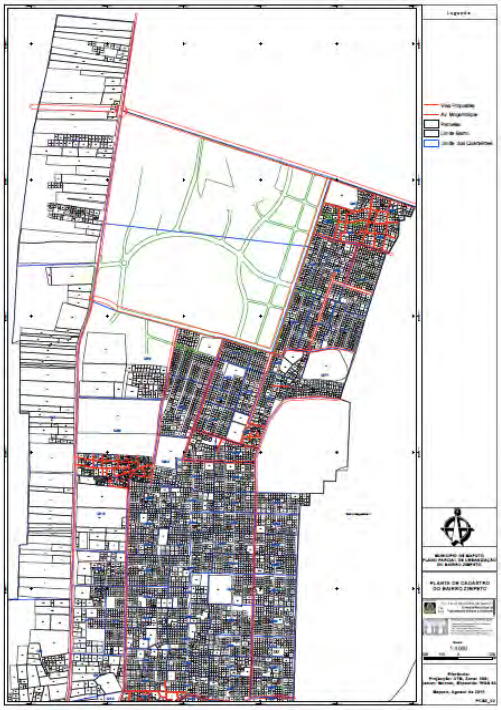


Source: PEUMM

Figure D.18: Zimpeto Condition Plan from PEUMM

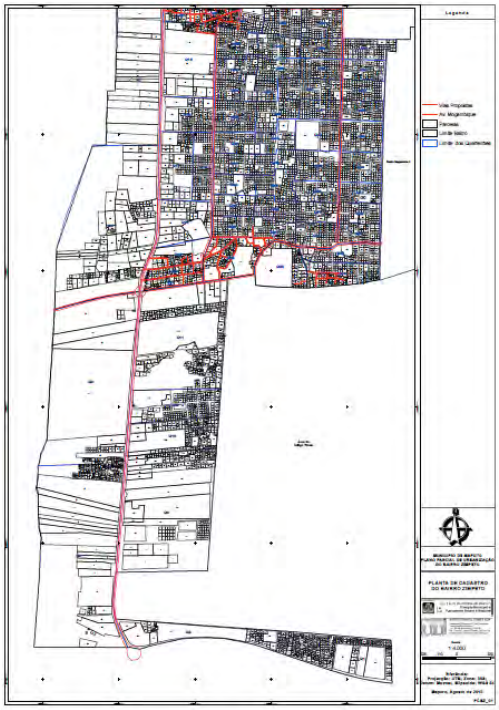
ProMaputo Phase 1 includes the preparation for the Partial Urbanization Plan for the district of Zimpeto which includes the provision of licenses for urbanized residential areas, the redevelopment of informal housing occupation to ensure the DUAT (right to the use and benefit of land), and to provide guidance and details on the implementation of urban infrastructure and public services.

Figure D.19 and Figure D.20 show the DUAT regularization of the parcels in the Zimpeto District Cadastre.



Source: Zimpeto Partial Urbanization Plan

Figure D.19:
Zimpeto District Cadastre 2



Source: Zimpeto Partial Urbanization Plan

Figure D.20:
Zimpeto District Cadastre 1

Marracuene

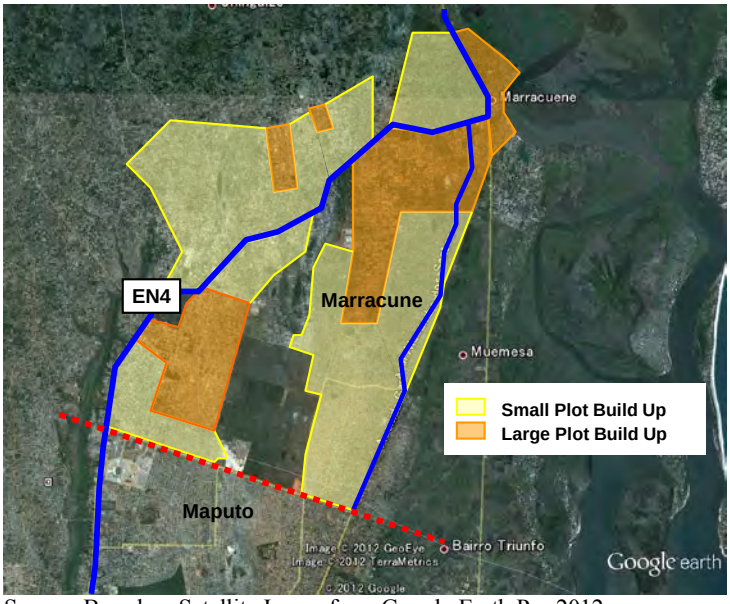
The recent rapid, unplanned urban development in Marracuene has highlighted the importance and necessity of a Land Use and Urban Structure Plan for Marracuene. The District of Marracuene is currently preparing the district land use plan with the technical support of a Maputo-based private consulting company (DHV).

In the meantime, as shown in Figure D.21, aerial images suggest that build up in Marracuene is catching up to those in the Northern Maputo, such as Zimpeto.

Source: Based on Satellite Image from Google Earth Pro 2012

Figure D.21: Comparison of Land Build Up of Marracuene and Zimpeto by Aerial Image

Figure D.22 shows the visual build up roughly identified from an aerial image. Much of the development is residential and the region is anticipated to become a residential suburb for those working in Maputo[9].



Source: Based on Satellite Image from Google Earth Pro 2012

Figure D.22: Visual Build Up in Marracuene from Aerial Image

Villa Boane

The 2007 Census indicates that Villa Boane has a relatively high population density. As shown in Figure D.23, unlike Marracuene, much of the urbanization is limited to a 1.5 kilometer radius of the Villa Boane. Boane City authorities are currently conducting a land use study with the support from the Ministry of Environmental Affairs.

Source: Based on Satellite Image from Google Earth Pro 2012

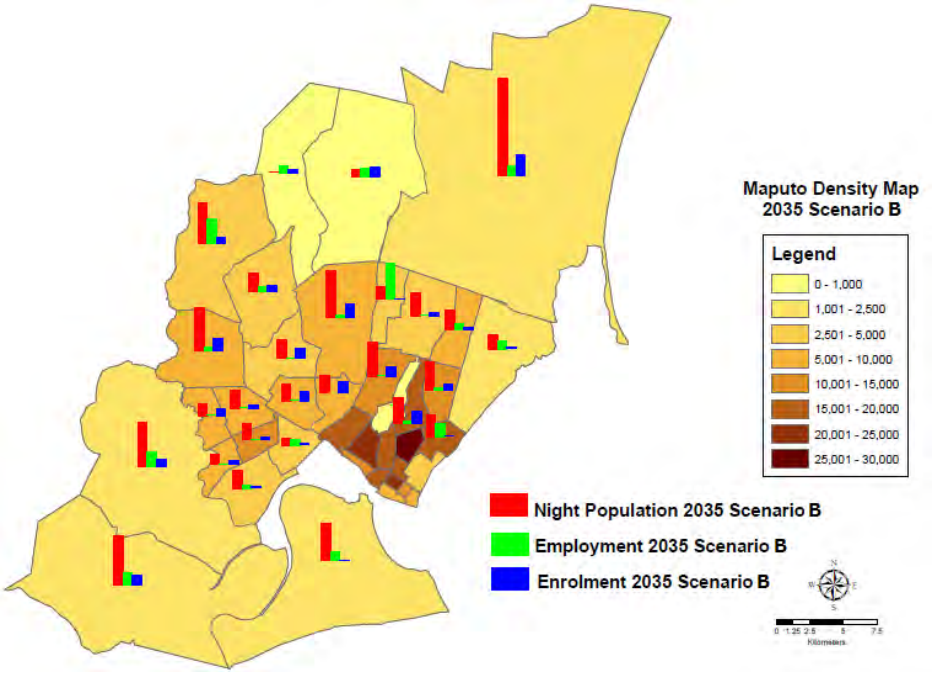
Figure D.23: Visual Build Up in Villa Boane from Aerial Image

[9] Based on interview with DHV on June 19, 2012.

Tchumene

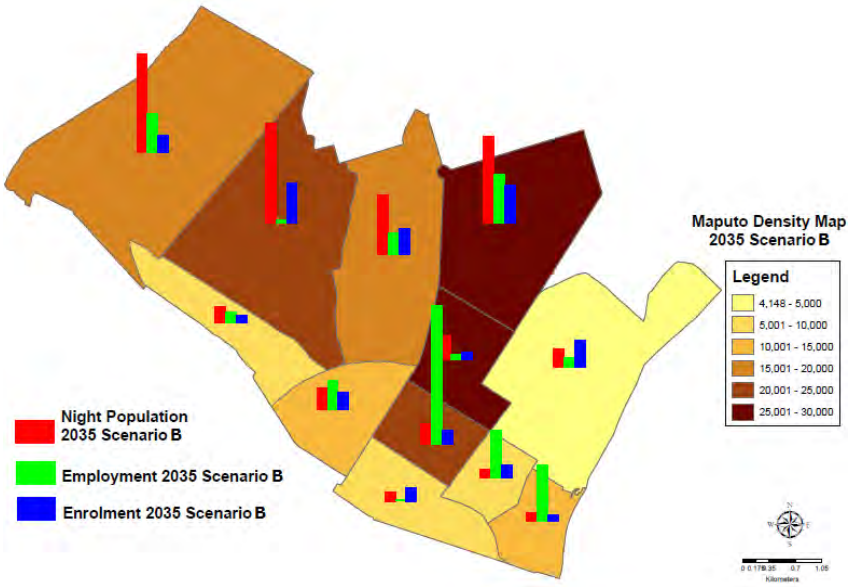
With the proposed new Ring Road connecting the EN1 and EN4, the junction at Tchumene is anticipated to grow in the near future. A new cargo terminal and a potential international bus terminal at Tchumene have been proposed in the PEUCM.

The socio-economic distribution for polycentric satellite center development is summarized in Figure D.24 and Figure D.25.



Source: JICA Project Team

Figure D.24: 2035 Scenario B Greater Maputo Socio-Economic Distribution Nighttime Population



Source: JICA Project Team

Figure D.25: 2035 Scenario B Maputo Municipality CBD Socio-Economic Distribution

Preliminary Assessment

Scenario B (Poly-Centric Satellite Center Development) is a recommended alternative urban development pattern for the following reasons.

Pros:

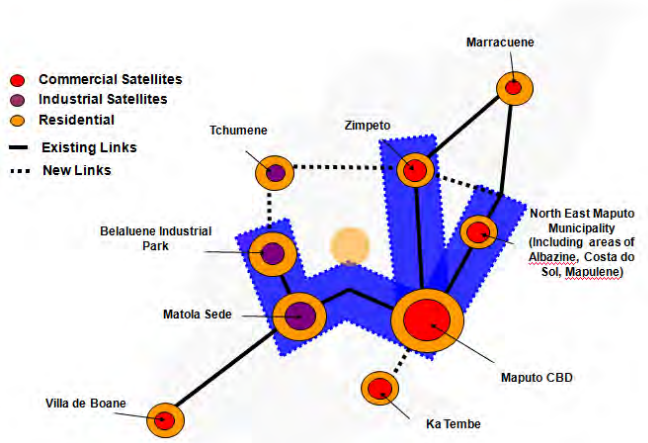
1. The existing Urban Structure Plans of Maputo and Matola as well as the urbanization plans of Pro Maputo already proposed potential growth neighbourhoods;
2. There is progress and existing momentum in the implementation of the above mentioned plans, including the necessary cooperation from local communities; and
3. Much of the identified poly-centres are already growing and will continue to grow as residential neighbourhoods

Cons:

1. As mentioned above, much of the identified poly-centres have significant residential occupations. While commercial uses are proposed in the various plans, it is difficult to determine the demand for commercial migration from the CBD to the mentioned poly-centres; and
2. Urbanization and commercial activity will be centred near the identified poly-centres and the area between each poly-center may end up becoming merely a link without much economic activity.

D.7.5 Scenario C: Compact Corridor Development

Figure D.26 presents a conceptual diagram of compact corridor development, which maximizes the utilization of the areas between the poly-centers mentioned for polycentric satellite center development. The socio-economic distribution for the polycentric satellite center development is summarized in Figure D.27 to Figure D.28.



Source: JICA Project Team

Figure D.26: Compact Corridor Development Pattern

The three potential Compact Corridors for Greater Maputo are summarized as follows.

Compact Corridor West: Maputo CBD – Matola Sede – Belaluene via EN2 and EN4

The linkage of Maputo CBD, Matola Sede, Belaluene via the EN2 and EN4 on the Maputo Economic Corridor can be considered for potential Compact Corridor Development. The link

between Matola Sede, also known as the "dormitory city" of Maputo, and Maputo CBD has historically been a major commuter corridor for the metropolitan area.

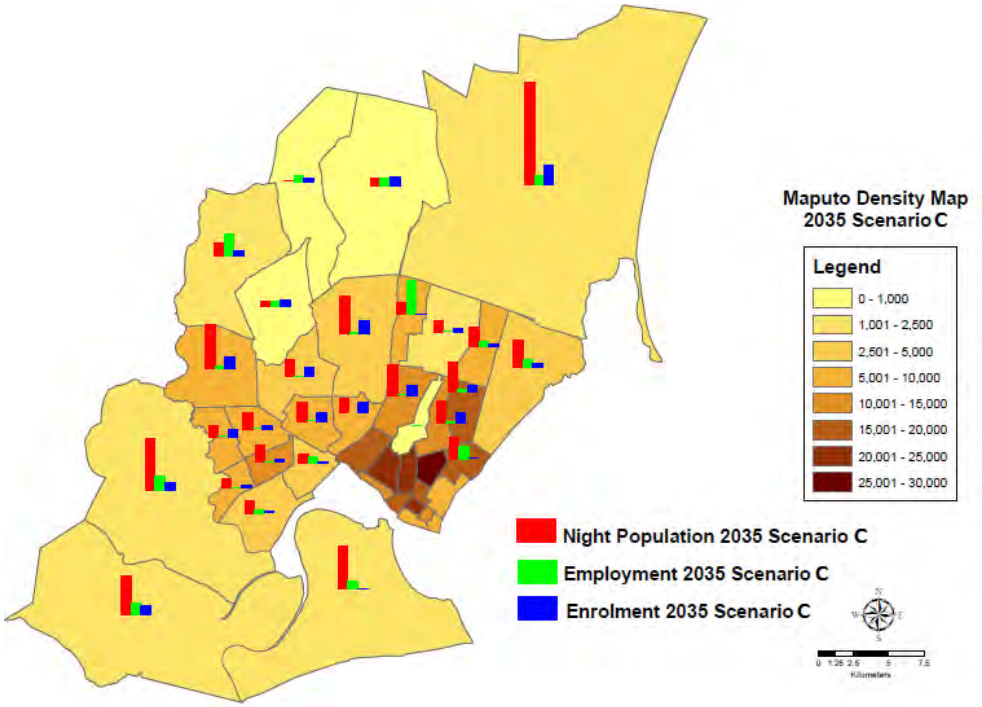
Furthermore, the aforementioned corridor has various economic potential along its route. Many enterprises are concentrated in District Kampfumu, District Nlhamankulu, and Matola Sede, which are transected by the mentioned corridor. Infrastructure enablers such as the Port of Maputo and Matola, as well as Belanuene are located along this route. These conditions suggest that the *Maputo CBD – Matola Sede – Belaluene Compact Corridor Route* has a significant potential in higher density mixed use economic development.

Compact Corridor Central: Maputo CBD–Zimpeto Via EN1

The linkage between Maputo CBD and Zimpeto via the EN1 transects District Kampfumu, District Nlhamankulu, and District Kamubukwana of Maputo, which are districts with high residential population. Furthermore, this corridor also has a significant amount of enterprise and industrial activity. These conditions suggest that the *Maputo CBD–Zimpeto Compact Corridor Route* has a significant potential in higher density mixed use economic development.

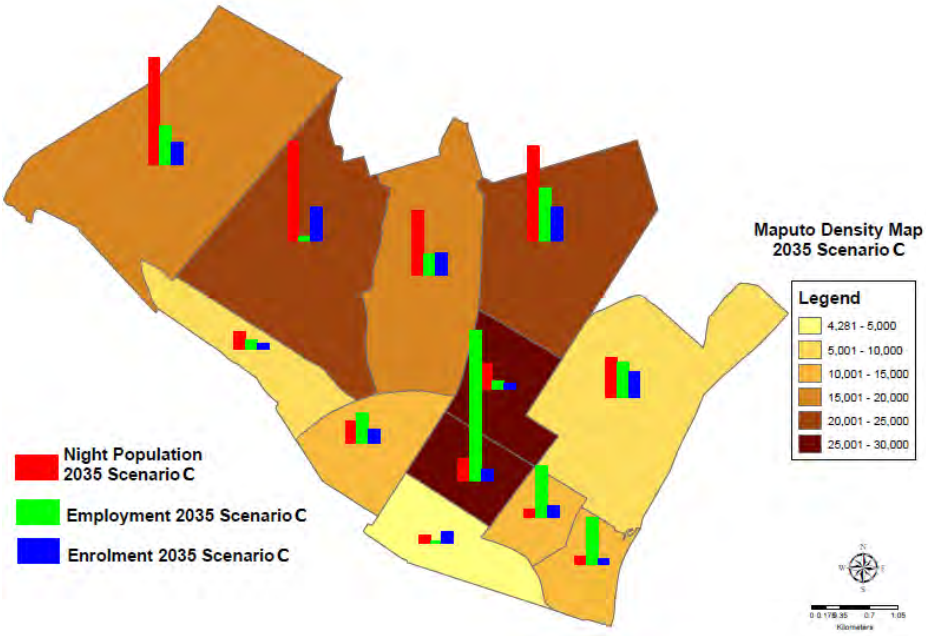
Compact Corridor East: Maputo CBD–Costa do Sol–Marracuene via Julius Nyerere and Avenida Coronel General Sebastiao Mabote (or Avenida Cardeal Alexandre dos Santos)

The linkage between Maputo CBD–Costa do Sol–Marracuene via Julius Nyerere and Avenida Coronel General Sebastiao Mabote is anticipated to benefit the inhabitants and activities on the eastern side of the National Airport. The corridor runs through the emerging residential neighbourhoods of Costa do Sol (Mapulene), Albazine, and Marracuene. While the commercial implications along this corridor are still to be explored, the conditions suggest that the *Maputo CBD–Costa do Sol–Marracuene Compact Corridor Route* has a significant potential in providing the necessary linkage to the emerging residential neighbourhoods.



Source: JICA Project Team

Figure D.27: 2035 Scenario C Greater Maputo Socio-Economic Distribution



Source: JICA Project Team

Figure D.28: 2035 Scenario C Maputo Municipality CBD Socio-Economic Distribution

Preliminary Assessment

Scenario C (Compact Corridor Development) is a recommended alternative urban development pattern for the following reasons.

Pros:

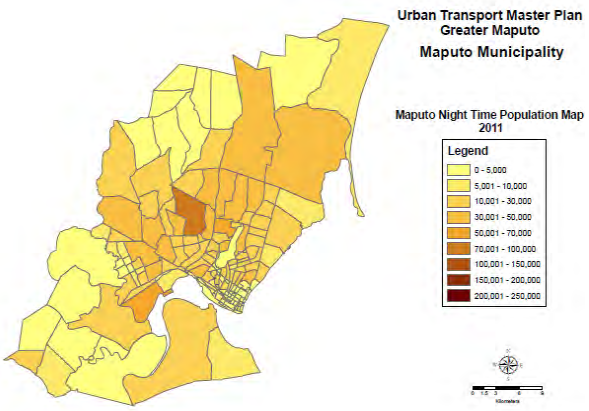
1. The existing land use and urban conditions, as well as proposed urban plans suggest economic development potential along the proposed compact corridor routes.

Cons:

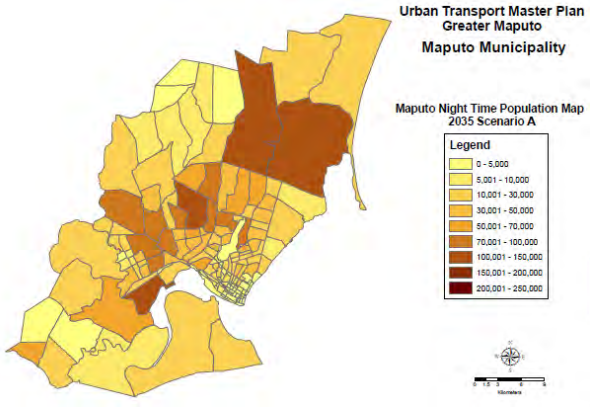
1. Compact Corridor West (Maputo CBD–Matola Sede–Belaluene) is along the same route as the toll road concession by TRAC and a portion of the proposed Ring Road, which will result in competition. Furthermore, the corridor is along the Maputo Economic Corridor, and increased commuter traffic mixed with freight traffic may require a significant upgrading of traffic capacity;
2. Compact Corridor Central (Maputo CBD–Zimpeto) is along the N1 which is also carries freight traffic. Increased urban traffic mixed with freight traffic may require significant upgrading of traffic capacity; and
3. Compact Corridor East (Maputo CBD–Costa do Sol) is a highly utilized urban corridor. However, with the proposed Ring Road, competition may be anticipated. Furthermore, as the corridor transects new unplanned residential neighbourhoods, expansion of existing roads may result in significant resettlement.

D.7.6 Distribution Differences by Scenario

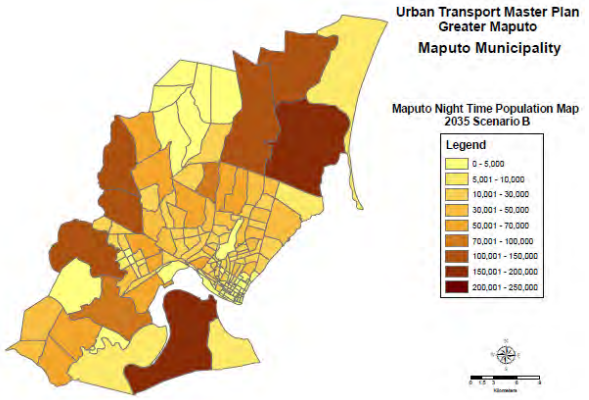
The differences in the distribution of night time population, employment, and enrollment for the different scenarios are summarized in Figure D.29 to Figure D.31.



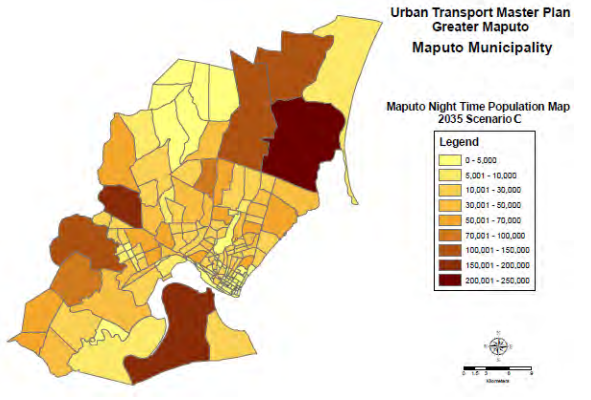
2012



2035 Scenario A



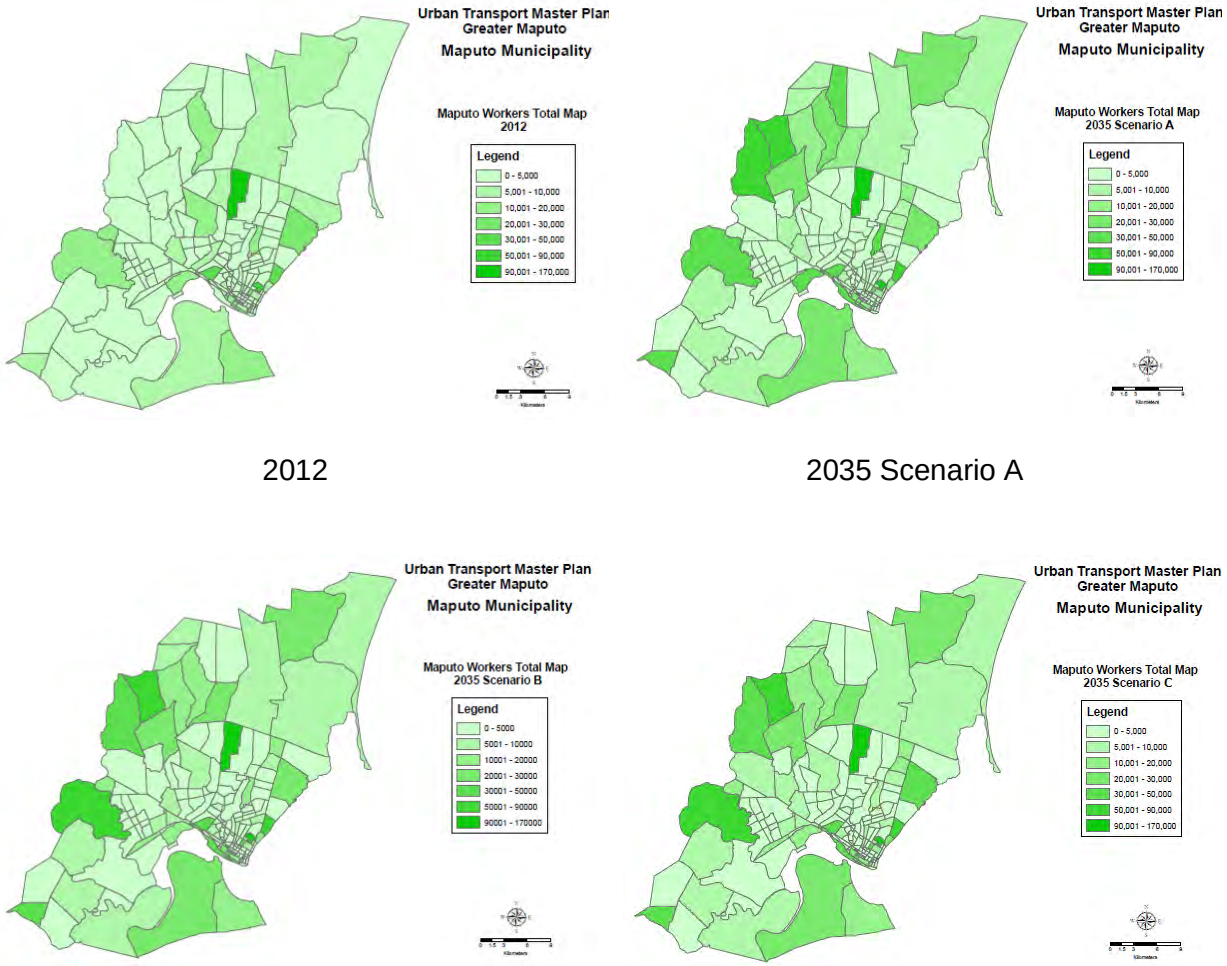
2035 Scenario B



2035 Scenario C

Source: JICA Project Team

Figure D.29: Night Time Population Distribution by Scenario

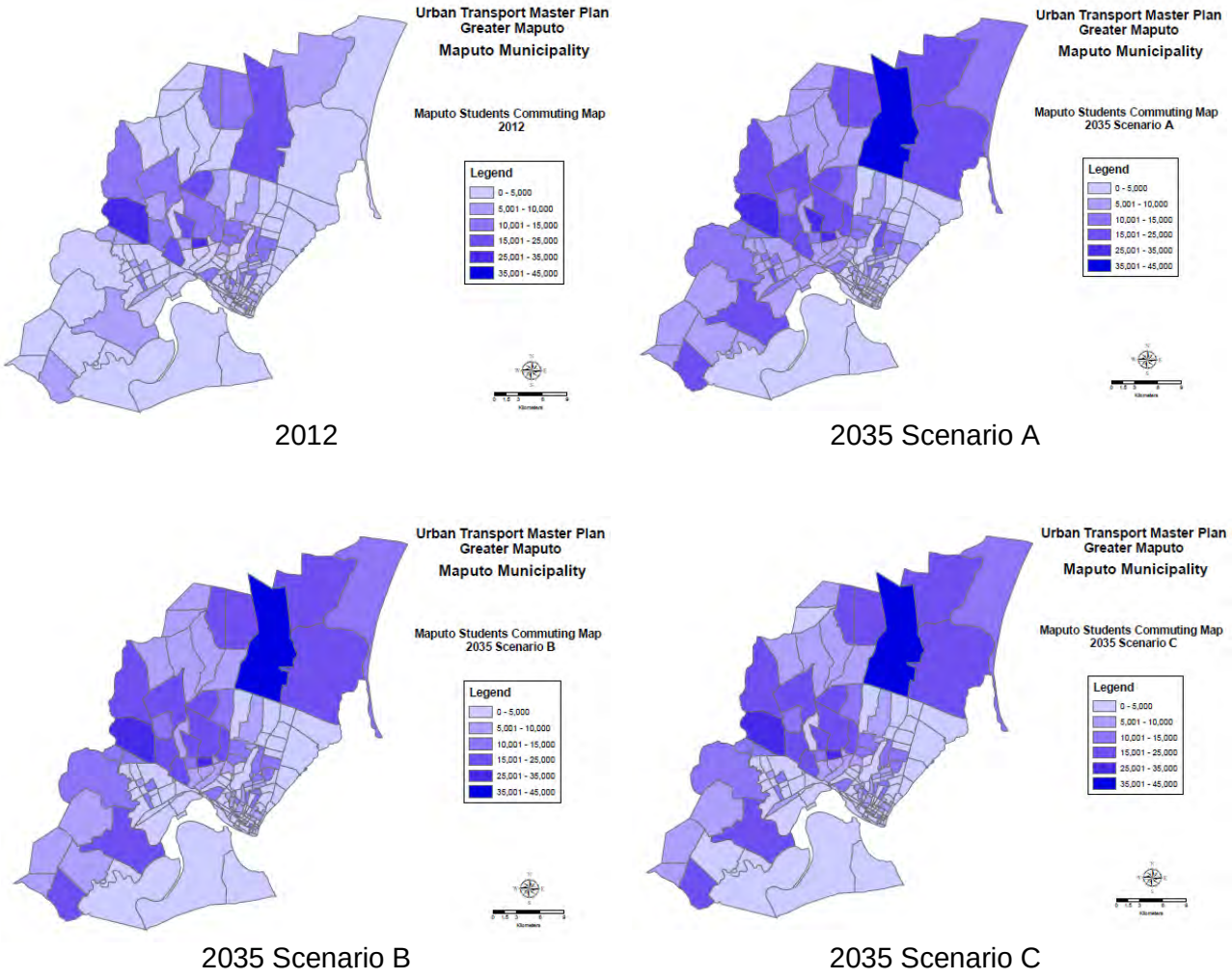


2012 2035 Scenario A

2035 Scenario B 2035 Scenario C

Source: JICA Project Team

Figure D.30: Employment Distribution by Scenario



Source: JICA Project Team

Figure D.31: Enrollment Distribution by Scenario

D.7.7 Socio-Economic Distribution by Numbers

The distribution of night time population, employment, and enrollment for the different scenarios are summarized by B-zone in Table D.6 to Table D.8.

Table D.6: Night Time Population and Total Employment by Scenario

B-zone Code Sequence		Area (km^2)	Night Time POPULATION (persons)				Employment Total			
			2011	Scenario A	Scenario B	Scenario C	2012	Scenario A	Scenario B	Scenario C
Maputo	1	1.09	8,220	9,261	10,123	10,149	12,906	18,696	25,000	23,450
	2	0.81	8,206	9,243	9,852	10,667	2,414	3,398	5,780	6,180
	3	5.12	7,973	8,983	10,686	8,562	58,548	116,994	129,191	122,391
	4	1.13	21,335	24,036	24,438	25,385	5,880	10,221	14,600	14,100
	5	1.63	21,316	24,012	25,443	25,347	30,371	36,753	40,970	40,195
	6	1.51	16,757	17,986	18,614	17,968	9,065	10,021	11,080	9,400
	7	5.04	15,240	41,573	20,739	25,489	112,396	183,321	199,000	199,750
	8	1.46	23,550	26,530	27,474	27,636	10,060	9,140	15,500	14,510
	9	6.62	91,575	98,562	99,256	102,563	40,609	56,437	57,652	58,602
	10	3.74	93,647	100,793	102,312	98,653	7,722	10,417	14,700	12,550
	11	3.65	64,037	68,843	70,332	79,504	5,200	6,641	16,050	17,200
	12	4.78	107,375	105,858	116,169	118,991	12,476	17,957	29,850	32,300
	13	6.39	80,207	114,158	116,023	123,742	35,766	44,718	49,850	52,300
	14	40.58	23,361	35,140	62,608	124,641	35,564	32,596	34,383	35,483
	15	9.22	100,271	135,224	128,812	143,003	7,942	9,852	12,932	15,532
	16	7.63	125,423	188,666	118,283	111,464	11,100	36,351	11,400	11,600
	17	6.71	0	0	0	0	1,763	2,554	2,000	2,500
	18	12.67	165,307	235,283	153,618	150,748	8,199	8,371	6,330	6,700
	19	11.81	61,303	92,215	89,587	91,806	14,068	22,151	25,419	28,419
	20	22.64	99,936	142,239	105,030	55,640	3,060	4,441	3,210	2,210
	21	10.70	33,444	47,601	53,503	58,853	114,638	159,513	162,427	162,977
	22	104.70	20,129	27,630	164,303	208,694	20,439	40,456	38,316	38,916
	TOTAL	269.61	1,188,612	1,553,836	1,527,205	1,619,505	560,186	840,999	905,640	907,265
Matola	23	16.01	69,507	142,195	80,661	61,133	5,242	3,353	15,100	14,530
	24	9.13	24,838	50,813	29,324	45,453	24,451	46,962	28,500	28,700
	25	6.38	31,142	63,709	45,943	47,858	2,586	2,568	6,000	6,600
	26	6.57	57,208	117,033	74,727	82,502	3,588	4,293	5,450	6,640
	27	9.31	27,686	56,638	51,983	55,706	4,688	5,935	5,000	5,250
	28	10.77	64,051	131,033	81,689	81,445	2,416	2,807	6,200	5,300
	29	11.53	81,079	165,869	74,887	92,119	7,009	7,326	6,700	7,950
	30	9.65	78,549	160,692	74,946	73,297	8,556	99	100	100
	31	30.13	56,179	114,931	195,826	210,889	14,820	6,361	16,337	17,837
	32	19.99	88,804	181,672	83,416	82,687	5,278	5,866	4,230	5,670
	33	41.90	179,887	368,004	211,735	182,019	19,043	2,361	12,360	10,570
	34	53.88	16,082	32,901	178,921	61,510	156	157,408	109,307	102,307
	35	30.04	27,383	56,018	83,661	22,207	23	25,483	21,307	21,102
	36	47.56	5,569	11,394	7,215	7,215	0	34,894	33,532	32,532
	37	77.95	19,511	39,913	36,441	39,689	20,598	92,976	41,118	37,868
	TOTAL	380.79	827,475	1,692,815	1,311,375	1,145,729	118,454	398,692	311,241	302,956
Marracuene	38	304.90	88,309	265,691	434,946	489,806	22,082	41,510	45,787	47,137
Boane	39	114.96	23,282	91,892	200,750	253,608	20,074	49,768	66,637	71,957
	40	137.42	41,416	92,365	222,322	187,946	19,121	54,484	56,149	56,139
	TOTAL	252.38	64,698	184,257	423,072	441,554	39,195	104,252	122,786	128,096
Greater Maputo Grand Total		1,207.670	1,207.67	3,696,599	3,696,598	3,696,594	739,917	1,385,453	1,385,454	1,385,454

Source: JICA Project Team

Table D.7: Agriculture and Industry Sector Employment

B-zone Code Sequence		1st (Agriculture) Sector Employment				2nd (Industry) Sector Employment			
		2012	Scenario A	Scenario B	Scenario C	2012	Scenario A	Scenario B	Scenario C
Maputo	1	0	0	0	0	0	0	0	0
	2	0	0	0	0	210	205	200	180
	3	11	0	0	0	430	30,725	29,191	28,891
	4	0	0	0	0	647	631	600	600
	5	0	0	0	0	15,366	15,014	14,970	14,945
	6	0	0	0	0	8,522	8,311	8,080	7,650
	7	0	0	0	0	0	0	0	0
	8	0	0	0	0	527	513	500	510
	9	511	352	352	352	4,240	4,134	4,300	4,500
	10	0	0	0	0	1,630	1,590	1,700	1,800
	11	0	0	0	0	1,890	1,844	2,050	2,450
	12	0	0	0	0	7,808	7,614	8,100	7,800
	13	2,349	0	0	0	9,034	8,810	9,100	9,300
	14	13,807	9,483	9,483	9,483	17,754	17,313	18,900	19,000
	15	1,206	832	832	832	1,561	1,523	1,600	1,700
	16	0	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0	0
	18	2,156	0	0	0	2,221	2,165	1,930	2,000
	19	2,054	1,419	1,419	1,419	0	0	0	0
	20	2	0	0	0	0	0	0	0
	21	144	727	727	727	14,976	14,604	14,700	15,000
	22	166	12,416	12,416	12,416	2,812	2,742	2,900	3,000
	TOTAL	22,406	25,229	25,229	25,229	89,628	117,738	118,821	119,326
Matola	23	47	0	0	0	1,394	1,768	1,600	1,530
	24	0	0	0	0	24,331	28,598	25,000	24,700
	25	0	0	0	0	1,748	2,218	2,000	2,100
	26	0	0	0	0	3,284	4,166	3,400	3,600
	27	11	0	0	0	4,677	5,935	5,000	5,250
	28	0	0	0	0	2,113	2,680	2,200	2,300
	29	400	0	0	0	5,364	6,806	5,200	5,450
	30	8,318	0	0	0	0	0	0	0
	31	539	337	337	337	0	0	0	0
	32	0	0	0	0	4,471	5,672	4,000	5,000
	33	9,240	2,359	2,359	2,359	0	0	0	0
	34	0	2,307	2,307	2,307	0	87,962	87,000	82,000
	35	1	2,792	2,792	2,792	0	18,451	18,000	17,800
	36	0	21,532	21,532	21,532	0	13,362	12,000	11,000
	37	5,136	2,568	2,568	2,568	0	21,728	21,800	21,800
	TOTAL	46,098	57,124	57,124	57,124	137,010	317,084	306,021	301,856
Marracuene	38	18,107	26,982	26,982	26,982	441	2,076	2,250	2,600
Boane	39	10,275	15,364	15,364	15,364	9,798	34,403	45,268	49,093
	40	10,106	21,124	21,124	21,124	0	0	25	15
	TOTAL	20,381	36,488	36,488	36,488	9,798	34,403	45,293	49,108
Greater Maputo Grand Total		106,992	145,823	145,823	145,823	236,877	471,301	472,385	472,890

Source: JICA Project Team

Table D.8: Service Sector Employment and Enrollment by Scenario

B-zone Code Sequence		3rd (Service) Sector Employment				Enrollment			
		2012	Scenario A	Scenario B	Scenario C	2012	Scenario A	Scenario B	Scenario C
Maputo	1	12,906	18,696	25,000	23,450	7,042	6,077	7,750	8,000
	2	2,204	3,193	5,580	6,000	14,084	12,155	15,500	16,000
	3	58,107	86,269	100,000	93,500	14,084	12,155	16,250	15,000
	4	5,233	9,590	14,000	13,500	14,084	12,155	16,250	16,000
	5	15,005	21,739	26,000	25,250	17,605	15,193	19,750	19,500
	6	543	1,710	3,000	1,750	7,042	6,078	8,500	8,000
	7	112,396	183,321	199,000	199,750	17,605	27,347	31,000	30,000
	8	9,533	8,627	15,000	14,000	7,042	6,078	8,500	9,000
	9	35,858	51,951	53,000	53,750	3,521	3,039	4,250	4,500
	10	6,092	8,827	13,000	10,750	42,252	36,465	45,000	44,000
	11	3,310	4,797	14,000	14,750	28,168	24,309	31,000	33,000
	12	4,668	10,343	21,750	24,500	42,252	36,464	47,250	48,500
	13	24,383	35,908	40,750	43,000	17,605	24,309	19,750	21,000
	14	4,003	5,800	6,000	7,000	3,521	12,155	10,750	13,500
	15	5,175	7,497	10,500	13,000	28,168	33,426	30,000	33,500
	16	11,100	36,351	11,400	11,600	42,252	60,774	54,000	55,000
	17	1,763	2,554	2,000	2,500	0	0	0	0
	18	3,822	6,206	4,400	4,700	42,252	57,735	45,750	46,500
	19	12,014	20,732	24,000	27,000	0	9,117	12,000	13,500
	20	3,058	4,441	3,210	2,210	10,563	18,232	14,750	13,500
	21	99,518	144,182	147,000	147,250	0	3,039	3,000	3,000
	22	17,461	25,298	23,000	23,500	0	6,078	6,000	6,000
	TOTAL	448,152	698,032	761,590	762,710	359,142	422,380	447,000	457,000
Matola	23	3,801	1,585	13,500	13,000	5,412	16,629	10,000	9,500
	24	120	18,364	3,500	4,000	0	11,086	10,000	10,000
	25	838	350	4,000	4,500	10,824	22,172	16,250	16,500
	26	304	127	2,050	3,040	0	16,629	15,000	14,000
	27	0	0	0	0	5,412	38,801	31,250	31,500
	28	303	127	4,000	3,000	5,412	16,629	16,500	16,000
	29	1,245	520	1,500	2,500	21,648	38,802	38,500	38,500
	30	238	99	100	100	27,060	49,888	49,500	49,500
	31	14,281	6,024	16,000	17,500	37,884	55,431	56,500	56,500
	32	807	194	230	670	32,472	49,888	44,000	43,000
	33	9,803	2	10,001	8,211	43,296	66,517	60,500	61,000
	34	156	67,139	20,000	18,000	10,824	22,172	25,000	22,500
	35	22	4,240	515	510	16,236	27,715	29,000	28,000
	36	0	0	0	0	0	16,629	17,769	15,769
	37	15,462	68,680	16,750	13,500	21,648	44,344	46,000	44,500
	TOTAL	47,380	167,451	92,146	88,531	238,128	493,332	465,769	456,769
Marracuene	38	3,534	12,452	16,555	17,555	31,429	95,864	96,500	96,500
Boane	39	1	1	6,005	7,500	13,845	37,568	38,000	38,000
	40	9,015	33,360	35,000	35,000	19,037	45,618	47,500	46,500
	TOTAL	9,016	33,361	41,005	42,500	32,882	83,186	85,500	84,500
Greater Maputo Grand Total		508,082	911,296	911,296	911,296	661,581	1,094,762	1,094,769	1,094,769

Source: JICA Project Team

Annex 1

National Development Vision and Policy

1. Agenda 2005

The Agenda 2025 provides a vision of the government for the development of Mozambique until the year of 2025. The Agenda 2025 is designed to help achieve the Millennium Development Goals, and decentralization is placed as a key to materialize strategies at the local level. Among the infrastructure strategies in the Agenda, the link between Provincial capitals and districts is regarded as essential to ensure all year around, with the provision of routine maintenance for the unpaved roads.

2. Five Year Government Program 2010–2014

Five-Year Government Program 2010-2014 is a five-year development strategy of the Government of Mozambique. The Program states poverty reduction as the central objective of the Government Program 2010-2014, which aims to improve the conditions of Mozambican people in a peaceful, harmonious, and tranquil environment. There are three main categories to help achieve the objectives of poverty reduction as follows;

a) Human and Social Development;
b) Economic Development; and
c) Good Governance, Decentralization, Fight Against Corruption, and Promotion of Culture of Account Rendering.

In the category of Economic Development, there are 13 sections of development strategies. In the sub-section of road transport development, 13 transport strategies are articulated, of which the sustainability of urban transport network and municipal enterprises of urban public transport have been clearly stated as important strategies, as shown in Table 1.

Table 1: Road Transport Strategies in the Government Program 2010–2012

	Transport Strategies
1	Expand and improve the Examination Centre of automobile transport, in order to improve a quality of drivers
2	Raise conditions for inspection and maintenance of vehicles
3	Promote the improvement of traffic road signalization
4	Improve and implement the Road Code
5	Intensify traffic control efficiency in public roads
6	Introduce concessionary system of routes for public transport of urban and inter-urban passengers in order to reduce insufficiency of transport and waiting time at bus stops.
7	Encourage the use of alternative means of transport, especially for bicycle, motorized and animal tractor vehicles.
8	Promote an appropriate system of rural transport
9	Establish sustainability basis of Urban Public Transport
10	Encourage the creation of Municipal Enterprises of Urban Public Transport
11	Formulate and implement an integrated system of tickets and inter-modalities
12	Reinforce the urban transport network
13	Promote the construction of urban inter-modal, inter-provincial and international road terminals of passengers and freight

Source: GOM, The Five-Year Government Program 2010-2014.

Decentralization is seen as an essential instrument to establish the necessary conditions for local administration to provide efficient public services for the citizens and confront the challenge of poverty reduction. In the supporting pillar of "Administrative Decentralization, Reform, and Local State Organs", the following two strategies for Local State Organs (Orgaos Locais do Estado: OLEs) are formulated:

a) Expand the organization and establishment of OLEs to the level of Locality (Localidade) and Village (Povoacao).
b) Continue the program of infrastructure construction by the Local State Organs.

For the development of urban municipality, five strategies for the gradual increase of number of municipals and the improvement of urban public services have been promulgated in the Program, which include the improved public transport services to the citizens (Table 2).

Table 2: Strategies for Development of Urban Municipality

	Municipal and Urban Development Strategies
1	Continue the gradual increase of municipals and the consolidation of municipals
2	Proceed the trainings of office-holders, and members of local municipal governments as well as civil servants and technicians
3	Strengthen the systems and mechanisms of communities account rendering by Municipal management
4	Continue to elaborate and implement complementary regulations for attributions and competences with full execution by the Municipality
5	Promote the rehabilitation and construction of urban infrastructure to improve the quality of public services and more adequate conditions for officers of the Municipal governments.

Source: GOM, The Five-Year Government Program 2010–2014

3. Poverty Reduction Action Plan (PARP) 2011–2014

The Poverty Reduction Action Plan (PARP) 2011–2014 is the key strategic instrument to implement the strategies set out in the Five-Year Government Program. The PARP consists of three pillars for the objectives of combating poverty, namely; 1) Increase in agricultural and fishery production; 2) Promotion of employment, and 3) Promotion of Human and Social Development. In the Human and Social Development Pillar, urban mobility is enlisted as one of priorities in social infrastructure development. It is importantly stated that urban mobility can be improved by:

a) Liberalizing transport fares, while maintaining protection for workers and students travelling to and from work or school, as well as the most vulnerable population groups, regardless of their commuting destination;
b) Creating conditions for purchasing more buses, boats and other collective transport equipment, standardizing trademarks and ensuring that they are adapted to local operating conditions and are mechanically simple.

In order to meet the needs for providing adequate public services to citizens, the government of Mozambique adapted the gradual decentralization of decision-making power and financial functioning to local government organs. Table 3 shows the strategies of gradual decentralization related to this study.

Table 3: Selected Strategic Objectives Related to Decentralization in PARP

Pillar/ Support Pillar	Strategic Objectives	Strategies
Good Governance	Institutional Reform and Capacity Building for Local Administration	Strengthen the capacity of OLEs to manage public resources (planning, financial management and implementation) for local government in a participatory and transparent manner.
		Construct or rehabilitate administrative infrastructure for OLEs and economic infrastructure
		Increase budget transfers to OLEs and municipalities
	Enhancement of municipality functions and improvement of urban development	Continue the transfer of functions and competencies to the municipalities
		Train the municipalities in administrative management, revenue collection, service delivery, territorial planning, and land use management
		Implement projects under the Strategic Plan for Urban Poverty Reduction in 11 municipalities

Source: GOM, Poverty Reduction Action Plan (PARP) 2011–2014

4. Transport Policy

The Transport Policy 5/96 was promulgated in 1996. Section of 4.1 in the Transport Policy states a policy of urban public transport (passenger transport) as follows:

a) Develop passenger transport with priority for public transport (*transporte collectivo*);
b) Assure passengers of public transport in greater urban centres, through public enterprises of which can enter in the plan of private management, considering social character of their operation, define an appropriate tariff policy;
c) Guarantee road security in the transport of persons; and
d) Assure the license of private economic agencies for the exploration of internal and periphery routes to urban centres according to the existent flow.

Although the above policy statement indicates social character of urban public transport, especially in terms of transport tariff, section 4.2 of Policy of Semi-Collective Transport of Passenger (so-called *chapa*) states a transport policy of semi-collective transport for the purpose of the development of the private sector as follows;

a) Encourage the development of the private sector in the segment of transport where there would be deficient, or inadequacy in public transport of passengers;
b) Guarantee road security in the transport of persons; and
c) Encourage the transformation of semi-collective transport of passengers in enterprises of public transport, correctly structured.

5. Decentralization Policy

Mozambique has dual local administration systems, i.e., 1) municipality (*autarquia*) in the urban areas and 2) local state organs (LOEs) in the rural areas. Law 2/97 legislated the transfer of some decision-making power and financial autonomy for urban municipalities in Mozambique. Some public services such as education, health and basic sanitation became attributed to the municipal level.

Decree 33/2006 provided the further devolution of power to municipalities in the provision of public services, since the government of Mozambique saw local administrations as being better

located and more efficient for providing public services to the citizens. The decentralization of state's functions and public finance to urban municipalities should be operated in ways of "gradualism" to allow the creation of required technical capacity and human and financial capacity of local state organs in Mozambique. Decree 33/2006 enlarged the functions of urban municipalities in providing public services, which includes public services in the transport sector, as follows:

a) Green space, including garden and municipal nursery;
b) Roads, including pedestrian pavements;
c) Economic residence;
d) Infrastructure of public utility of municipal management;
e) Public cemetery;
f) Installation of public services of municipal;
g) Markets and fairs; and
h) Fire station.

The planning, implementation, and public financing for the transport network and roads have been devolved to urban municipalities, with some reservation to the central government and the National Road Administration (ANE). Table 4 describes the devolution to municipalities in the transport and road sectors.

Table 4: Devolution of Transport and Road Functions to Municipality Organs by Decree 33/2006

Article	Function	Description of Decree
9	Transport and Communication	It is Municipality's competence to plan, manage, and execute investments in the following areas: a) Urban and rural road network under the Municipal jurisdiction b) Public transport network developing exclusively in the area of Municipal,
		It is Municipal divisions' competence to set the annual quotas and vehicles permit of public transport, mini-bus (chapas), and taxies taking into account the licensing law in force at the national level
10	Road	According to the Decree n°20/2003 of 20 of May, it is Municipal competence of: a) Management and maintenance of roads under the Municipal jurisdictions except primary, secondary, and tertiary, and vicinal roads b) Coordination with ANE in the management, maintenance, and development of primary, secondary, and vicinal roads that pass the area of municipal c) Financing of development, maintenance, and management of roads and related infrastructure of urban roads d) Implementation of applicable legislation to roads and its regulation in the domain of its ability e) Introduction of utilization tax of roads and linked infrastructure in the Municipality jurisdiction f) Concession of roads exploration under its jurisdiction
		ANE is, in relation to regional roads administration, responsible for proposing rules to be observed by local municipalities in funding, developing and maintaining urban roads.
		Road Funds is responsible for disbursing 10 % of funds from fuel tax, for the payment of services and works related to the rehabilitation of urban roads and infrastructure in the jurisdiction.

Source: GOM, Decree 33/2003

While urban municipalities have more autonomy from the central government, OLEs are given the limited decision-making power and public financial autonomy. This reflects the fact that presidents of urban municipality are to be elected by people, while local administration heads such as Provincial Governors and District Administrators are to be nominated by the central government. Law 8/2003 legislates the structure and functions of OLEs at the provincial, district, post administration and locality level. Districts are the basis of local administration in the rural areas of Mozambique, and District Plan and Budget has been established by Law 8/2003 and transferred directly from the central government.

6. Five Year Program of Maputo City Council 2009–2013

Maputo City Council has formulated its own Five-Year Program between 2009 and 2013, which was based on the Frelimo's electoral manifestos in 2009-2013. The principal challenges of the Municipal were identified in 6 scopes of the vision as follows:

a) Necessity of improving Municipal governance;
b) Improvement of strategic and operational planning;
c) Strengthen institutional development and human resources;
d) Improvement of financial management;
e) Improvement of quality in Municipal service provision; and
f) Necessity of mobilizing additional funds for Municipal development necessary for the development of infrastructure and equipment in the Municipality.

For the improvement of quality in municipal public services, the Municipality completed a survey in 2007, with the results showing that the citizens placed the priority for municipal public services in order of: 1) solid waste removal; 2) road condition and access; 3) concession of construction license; 4) municipal policy; 5) cemetery and funeral services; 6) concession of garden; 7) public transport; 8) potable water supply; 9) security in bairros; and 10) public lighting.

On the basis of the above visions, the Municipal defined 15 priorities in the Five-Year Program, including the following strategies related to the Study (Table 5).

Table 5: Selected Strategies in the Five Year Program of Maputo City Council

Strategies	Description
Improve and guarantee the sustainability of Municipal finance	• Increase fiscal revenue in CMM by increasing the registration of citizens and various fiscal obligation • Increase efficiency of coverage system of duties (impostos) and taxes
Develop a local and social economy	• Promote private investment projects in infrastructure and municipal services through Public-Private Partnerships (PPPs)
Develop Municipal infrastructure	• Construction or rehabilitation of road network, with priority for alternative access road to the Municipal in general and in particular in sub-urban zones • Construction of Catembe Bridge in coordination with the central government and other partners • Elaboration and implementation of Municipal Transport Master Plan • Improvement of public transport regulations in the Maputo Municipal

Source: Maputo City Council, Five-Year Program of Maputo City Council 2009-2013

Annex 2

Transport Sector Investment Program

1. Five Year Program of Maputo City Council

In coordination with priority strategies established in the Five Year Program of Maputo City Council as described in Annex 1, Maputo City Council provided specific objectives and targets for an investment program in the Five-Year Program. Table 1 shows specific objectives and targets in the "Municipal Infrastructure Development", i.e.,

1) Improvement of urban transport
2) Improvement of current road conditions and Assurance of future expansion

Some specific targets such as the elaboration of Transport Master Plan and construction of adequate parking spaces have been currently implementing in the Municipality.

Table 1: Specific Objectives in the Five Year Program: Improvement of Urban Transport

Expected Result	Activity	Goal	Term	Responsible organs	Current Status
Transports Master Plan - elaborated and under implementation	• Elaboration and implementation of the Transports Master Plan	Master Plan elaborated and implemented	2010	**VTT**	**Commenced in Feb. 2012**
Rehabilitation and construction of bus terminals	• Construction of a bus terminal in Benfica • Rehabilitation and construction of Special Terminals: Xiquelene, Museu, Xipamanine, Baixa, Magoanine, CMC and Laulane • Construction of an inter-urban bus terminal in Zimpeto • Construction of an inter-provincial bus terminal in Junta • Organization and regulation of the use of squares and taxi terminals, and improvement of its surveillance • Completion of Baixa International Bus Terminal and installing its management system	Construction and rehabilitation of bus terminals	As from 2010	**VTT**	**(Planned?)**
Construction of adequate parking spaces for vehicles	• Identify sites, run the feasibility study and elaboration of TORs • Drawing, PPP budgeting and bidding, work contract, execution, surveillance and completing of works	Construction of new parking-places (goal to be defined each year in the plan of activities)	Annual	**VTT**	**(On-going)**
Municipal service of public transport – implemented on PPP modality	• Creation of the Municipal Enterprise for Road Transport • Promotion and facilitation of the process of creating transport enterprises in the municipality and concession of routes • Definition of new lines for passenger transportation and concession to transport companies • Creation of a Committee for Mobility and Transports in Maputo • Ensure the management and organization of the passenger transportation system in Maputo	Creation of the Municipal Enterprise for Roads Transport Public Transport service implemented	As from 2009	**VTT**	**(On-going)**

Expected Result	Activity	Goal	Term	Responsible organs	Current Status
Construction of adequate parking spaces for vehicles	• Implementation of the Rotational Parking System • Construction of car-parks • Elaboration and implementation of the semi-collective transports (*Chapa*) regulations	New parking-places constructed (specific goals to be defined in the annual plan of activities)	As from 2010	**VTT**	**(On-going)**
Regulated public transport business	• Elaboration of passenger, freight and taxi transportation regulations • Concession of routes of public transport • Organization and introduction of a new surveillance system for public transports in Maputo • Promotion of transit education programs • Construction of a Regional Road Commutation Terminal and Urban Road Terminal – next to Missão Roque square	Public Transports Surveillance System redesigned and implemented	As from 2009	**VTT**	**(On-going)**
	• Ensure the organization of intermodal transport through the rational use of the Maputo Bay and railways prospects • Monitoring of the process of acquisition and operation of passenger vessels to Catembe and Inhaca	Economic feasibility studies executed New operational vessels for Catembe and Inhaca	2009	**VTT**	**(On-going)**

Table 2: Specific Objectives in the Five Year Program: Improvement of Current Road Conditions and Assurance of Future Expansion

Expected result	Activity	Goal	Deadline	Resp. Organs	Current Status
Rehabilitated roads/new roads	• Construction and rehabilitation of roads, to assure mobility of the access routes through paving roads and construction of new roads in the suburbs.	150 km of constructed and rehabilitated paved and unpaved roads, especially the following:	2013	VI	On-going
		✓ Av. Milagre Mabote – inaugurated	2010		(Planning?)
		✓ Av. Nelson Mandela – Inaugurated	2012		(Completed in year?)
		✓ Av.J. Nyerere – rehabilitated	2009		Commence in 2012?
		✓ Av. Joaquim Chissano II section Inaugurated	2010		
		✓ Av. Don Alexandre – Inaugurated	2012		
		✓ Av. Do Grande Mapuyo – Inaugurated	2012		
	• Catembe bridge construction in coordination with the government and other partners	Mobilize necessary funds and initiate the construction of the Catembe bridge	2013	**VI**	
Road signalization Fully functional	• The working up of a project, fiscalization hiring, works and maintenance execution • Updating and implementation of the (II Fase do Relatório sobre Gestão do Trafêgo Urbano)" II Phase Report on Urban Traffic Management" • Implementation of traffic control • Implementation of maintenance and signalization in the main roads	Road are 100% signalized	2013	VI VTT	
Drainages fairly maintained	• Elaboration of projects, contract of audit, execution of works, maintenance and conservation	Sanitation and Drainage plan approved and implemented	Annual	**VI**	**(on-going?)**
Maintenance strategy	• Elaboration and implementation of regular maintenance strategy of roads in the Municipal Districts.	Maintenance strategy fully implemented	Annual	**VI**	**(on-going?)**

2. Externally Funded Investment Projects

Most transport infrastructure projects in the Greater Maputo Region have been jointly financed by external resources, the central government, and the Maputo City Council. In the case of the World Bank's and other loan projects, infrastructure investments have been jointly financed by Maputo City Council, Ministry of Planning and Development, and Ministry of Finance. Maputo City Council is allowed to finance up to USD 50 million for loan projects. Most investments in the transport sector have been concentrated in infrastructure improvement, while soft measures such as the improvement of public transport and traffic system have been relatively deficient. In addition, most investments have been located within Maputo City, while transport infrastructure in the surrounding areas such as Matola and access roads from sub-urban areas to Maputo City Centre have been less invested and seriously needed, with the increasing migration from Maputo to the surrounding sub-urban areas.

Table 3: Investment Program Financed by External Resources

	Project name	External financier	Project cost	Period	Description
1	Ring Road Project	China EXIM	USD 315 million (USD 300 million from China, 15 million from GOM)	June 2012-	74 km of road construction and rehabilitation to connect Maputo, Marracuene, and Matola
2	Maputo Municipal Development Program II (ProMaputo)	The World Bank	USD 105 million (10 million for Av. Julius Nyerere, 1 million for traffic control)	Jan.2011 – Dec. 2015	Rehabilitation o f Av. Julius Nyerere, traffic control centre
3	Coastal Road Protection Project	BADEA (Bank of Arabic Development Agency)	USD 12 million	June 2012 -	13 km of coastal road projection work in Marginal Road
4	Ka Tembe Project	Not determined yet	–	–	Construction of Ka Tembe bridge and 100 km road to Ponta do Ouro
5	Maputo City Road Projects	Not determined, but negotiating with South Korea	USD 100 million	–	Based on 2010 road network study, road widening in 24 de Julho, FPLM, Eduardo Mondlane, and Julius Nyerere are proposed
6	PRPE2 – Road Rehabilitation in Maputo Municipality	Belgium	1,292,000 EUR (Grant)	2008-2012	Rehabilitation of Avenida Milagre Mabote
7	Project for Capacity Development of Road Maintenance	Japan	JPY 240 million (TA)	Aug. 2010 – July 2014	Road Maintenance, with planned model case in the project area

Source: JICA Project Team, ODA Moz, World Bank

Technical Report E

Road Sector

Contents

Figures

Tables

Technical Report E Road Sector

E.1 Road Administration

The major arterial road network that connects national roads across the region is managed by the National Road Administration (*Administração Nacional de Estradas*, ANE). ANE is a semiautonomous road authority that develops and maintains a large part of the arterial roads in Mozambique following government policy. Previously, ANE was under the jurisdiction of the Ministry of Public Works and Housing. However, in 1999 it became a semiautonomous organization with the former Department of Roads and Bridges separated from the ministry. In Greater Maputo, part of the arterial network has been developed by the private sector, including Trans African Concessions (TRAC), a private consortium, which built and operates the N4 toll road linking Mozambique and South Africa. Furthermore, each municipal (district) infrastructure department manages the rural and urban road network in its respective regions with the primary goal of maintaining road conditions. Table E.1 summarizes the management of the road network in Greater Maputo.

Table E.1: Organization of the Road Sector in Greater Maputo

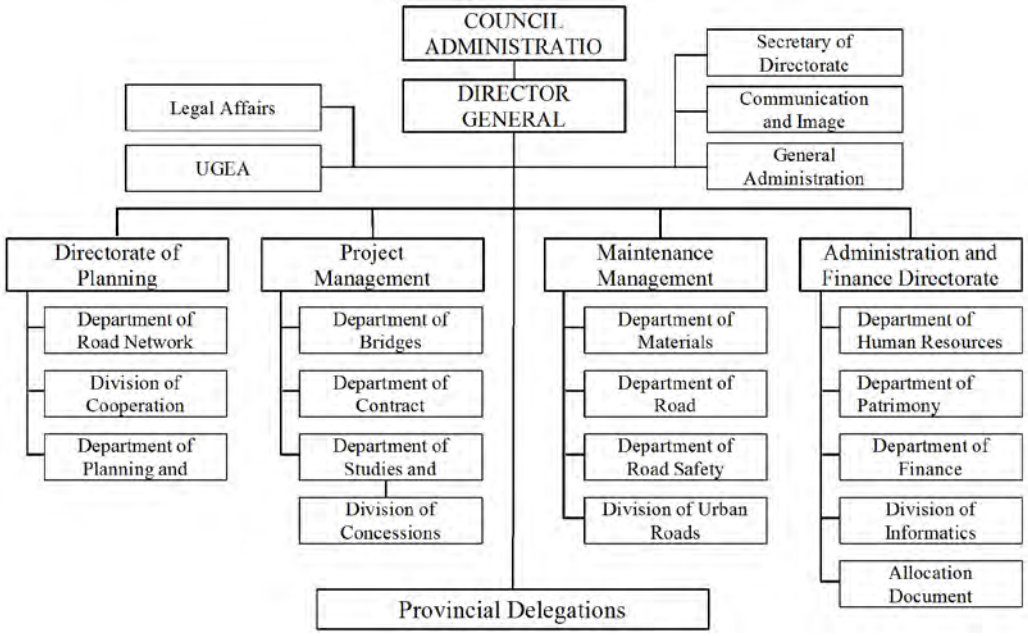
Organization	Summary
National Road Administration (ANE)	Manages about 37,000 km of national and regional roads in Mozambique. In Greater Maputo, ANE manages the N1, N2, R200, and other roads, including unpaved road sections.
Maputo, Matola, and Boane Municipal Infrastructure Departments	At the municipal level, these departments hold jurisdiction over the rural and urban road networks including the arterial roads in Maputo city district.
Marracuene District Infrastructure Departments	This department has jurisdiction over the road network at the district level.
Trans-Africa Concessions (TRAC)	Manages and maintains about 600 km of the N4 toll road, which connects Maputo to South Africa.

Source: JICA Project Team

E.1.1 National Road Administration (ANE)

(1) Organization System

ANE is the largest road management organization in Mozambique and has jurisdiction over a large part of the national road and major arterial road network. It has four administrative departments and ten local offices in provinces as illustrated in Figure E.1. Table E.2 shows the total number of engineering staff and clerical staff in the ANE organization; it is considered that generally the roads under ANE's jurisdiction have been managed relatively well with this staff complement.



Source: ANE

Figure E.1: Organizational Chart of ANE

Table E.2: Staff of ANE by Location and Staff Category

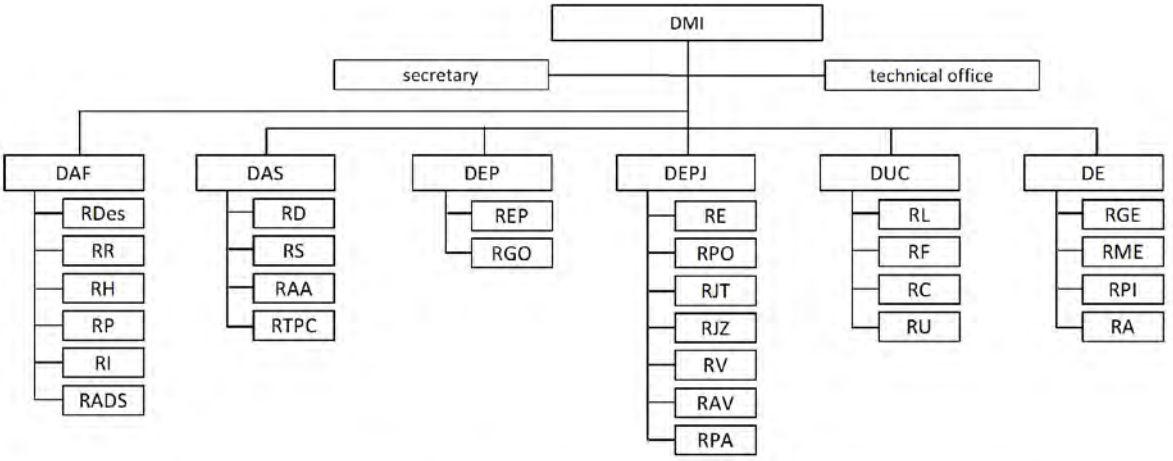
Location	Engineers	Clerical Staff	Total
Headquarters	120	73	193
Provinces	150	137	287
Total	270	210	480

Source: ANE

E.1.2 Maputo Municipal Council

(1) Organization System

The Maputo Municipal Council is a government body that is independent from the province. The development and maintenance of various roads and streets in Maputo municipal areas is undertaken by the municipality's Infrastructure Roads Department. The current size of the engineering staff may constrain the department's capacity to achieve a higher level of road maintenance given the total road length under its jurisdiction. The organizational chart of the Maputo Municipal Council Infrastructure Department is presented in Figure E.2, while staff size is shown in Table E.3.



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

Figure E.2: Organizational Chart of the Maputo Municipal Infrastructure Department

Table E.3: Staff of the Municipal Directorate of the Infrastructure and Road Department

Position	Municipal Directorate of Infrastructure (DMI)	Road Department (DE)
Superior Technician N1	40	3
Superior Technician N2	10	2
Professional Technician	46	7
Technician	11	3
Technical Agent	1	0
Technical Assistant	37	5
Office Assistant	44	7
Worker	41	17
Office Person	14	2
Assistant	273	35
Total	517	81

Source: Maputo Municipal Infrastructure Department

(2) Budget Overview

The maintenance of existing roads is funded under the municipal budget. The development of new roads has received financial support from development partners. Available funds have been insufficient for proper maintenance of the existing roads (as well as the development of new roads). Table E.4 shows the trend in budget allocation for road maintenance, rehabilitation, and new construction from 2007 to 2011.

Table E.4: Maputo Municipal Roads Budget, 2007–11

Unit: USD

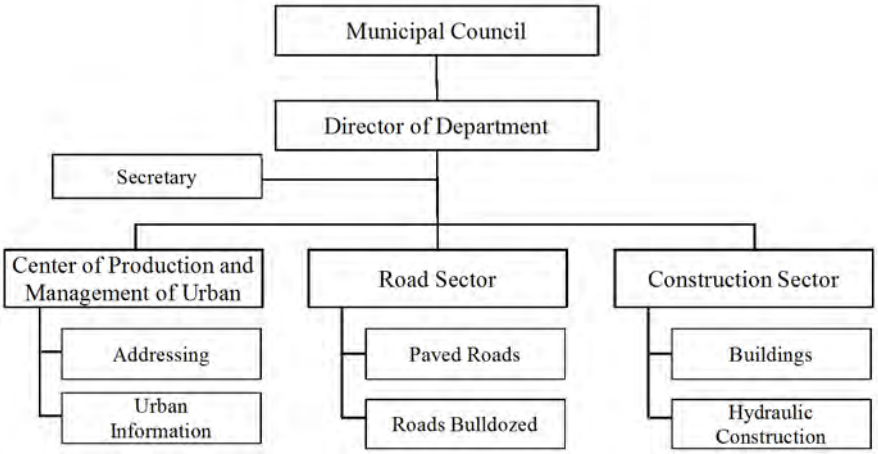
Component	2007	2008	2009	2010	2011
Routine maintenance	165,861	1,964,256	782,800	379,045	1,078,696
Periodic maintenance	-	-	-	9,465,925	4,415,846
Rehabilitation	11,425,959	12,925,959	-	-	-
Construction	-	-	8,743,991	5,393,024	-
Total	11,591,821	14,890,215	9,526,791	15,237,994	5,494,542

Source: Maputo Municipal Infrastructure Department

E.1.3 Matola Municipal Council

(1) Organization System

The roads under the jurisdiction of Matola Municipal Council are being managed, developed, and maintained by the road sector of council's Infrastructure Department. It has a small number of engineers and no road engineer, which is considered to a major constraint. The organizational chart of the Matola Municipal Infrastructure Department is shown in Figure E.3, and the number of office staff is shown in Table E.5.



Source: Matola Infrastructure Department

Figure E.3: Organizational Chart of Matola Municipal Infrastructure Department

Table E.5: Staff of the Matola Municipal Infrastructure Department

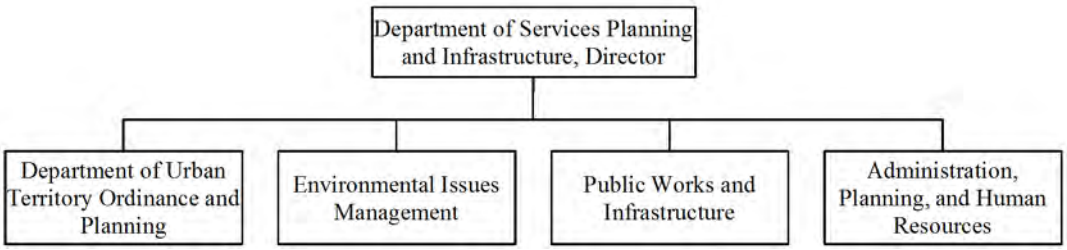
Section	Engineers	Others	Total
Road section	0	24	24
Construction section	4	13	17
Center for production and management of urban data	4	1	5
Total	8	38	46

Source: Matola Municipal Infrastructure Department

E.1.4 Marracuene District Council

(1) Organization System

The roads under the Marracuene District Council are managed and maintained by the Public Works and Infrastructure Department of Services Planning and Infrastructure. The department has five engineers, but this is insufficient for future development. The organizational chart of the Marracuene District Infrastructure Department is shown in Figure E.4.



Source: Marracuene District Infrastructure Department

Figure E.4: Organizational Chart of the Marracuene District Infrastructure Department

(2) Budget Overview

Table E.6 presents the Marracuene District Roads Budget.

Table E.6: Marracuene District Roads Budget

Unit: MT million

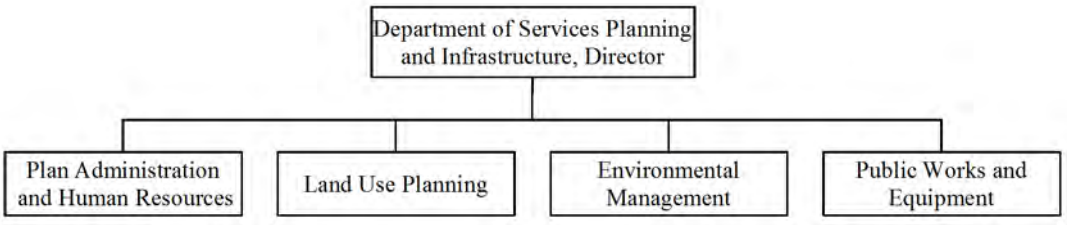
Component	2008	2009	2010	2011
Decentralized component	1,000,000	1,000,000	1,250,000	1,250,000
Maintenance routine	---	---	---	640,800
Support for the agrarian sector	1,000,000	1,000,000	1,250,000	1,890,800

Source: Marracuene District Infrastructure Department

E.1.5 Boane City Council

(1) Organization System

The roads under the jurisdiction of the Boane City Council are managed and maintained by the Public Works and Equipment Department of Services Planning and Infrastructure. The Infrastructure Department has an office staff of 14, two of which are engineers that serve as directors in the department and also in the Land Use Planning Division. The number of engineering staff members in the Infrastructure Department is insufficient to meet requirements. The organizational chart of the Boane City Infrastructure Department is shown in Figure E.5.



Source: Boane Infrastructure Department

Figure E.5: Organizational Chart of Boane City Infrastructure Department

(2) Budget Overview

Originally, the Boane City Council did not have budget for road maintenance, but only for office expenses. Its road maintenance budget comes from ANE. The budget allocation was MT 1.5 million in each year from 2006 to 2011, and then increased to MT 2 million in 2012.

E.2 Existing Road Network

E.2.1 The National Road Network

(1) ANE Road Network

As noted above, the national road and arterial road networks of Mozambique, totaling about 37,000 km, have been developed and maintained by ANE. The roads include primary, secondary, tertiary, and local roads.

The national roads fall under the category of primary roads, while regional roads are grouped into the secondary road class or lower categories. In addition, there are roads that are currently not classified. A breakdown of road lengths across Mozambique and in Maputo Province is presented in Tables E.7 and E.8 respectively, with the network of ANE roads in Province shown in Figure E.6.

Table E.7: Breakdown of Road Length in Mozambique

Unit: km

	Class	Non-Pavement	Pavement	Total
Classified	Primary	1,407	4,459	5,866
	Secondary	3,983	809	4,792
	Tertiary	11,645	516	12,161
	Local	6,500	30	6,530
Sub-total		23,535	5,814	29,348
Non classified	Urban	2,500	500	3,000
	Nonurban	5,000	---	5,000
Total		31,035	6,314	37,348

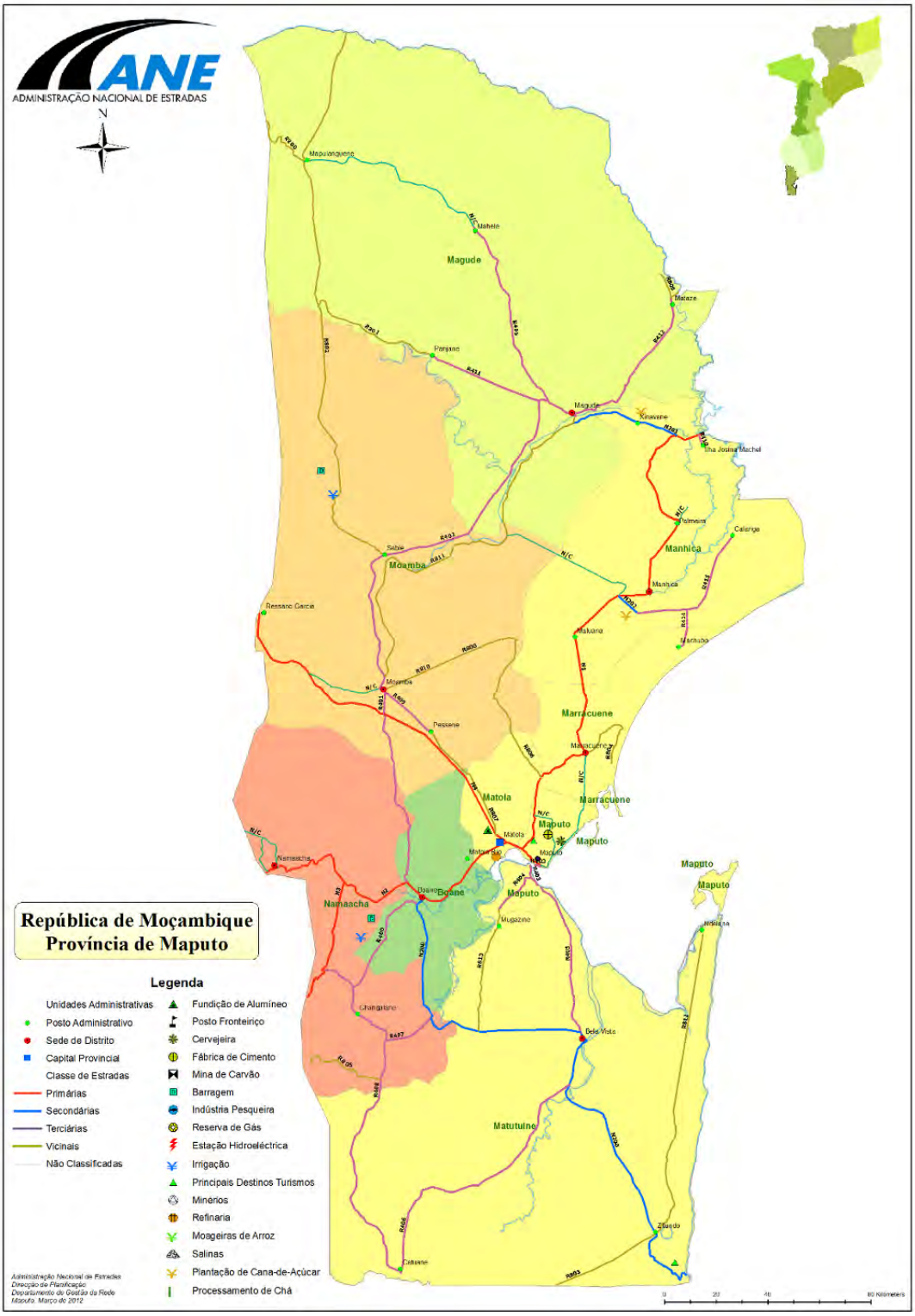
Source: ANE

Table E.8: Breakdown of Road Length in Province under the Jurisdiction of ANE

Unit: km

Province	Primary	Secondary	Tertiary	Vicinal	Total
Maputo	323	169	557	547	1,596
Gaza	276	690	988	573	2,527
Inhambane	558	265	1,140	930	2,894
Manica	513	336	960	635	2,444
Sofala	584	554	847	389	2,375
Tete	530	1,186	833	392	2,941
Zambezia	1,001	698	1,552	995	4,246
Nampula	996	165	1,965	934	4,060
Cabo Delegado	675	337	1,609	824	3,444
Nissa	414	392	1,620	371	2,797
Total	5,870	4,792	12,071	6,590	29,324

Source: ANE



Source: ANE

Figure E.6: Network of ANE Roads in Maputo Province

(2) TRAC N4

The N4 is a 600 km toll road that connects Maputo with South Africa. The road length in Mozambique is about 100 km and that in South Africa about 500 km. The N4 is under a concession agreement between the respective governments and TRAC, which is a private enterprise. Developed under a build-operate-transfer (BOT) concession, the road will be transferred to the government in 30 years. TRAC provided the initial construction and maintenance of the road, with financing from tolls. There are two toll gates in Mozambique, in Maputo and Moamba (see, e.g., the photograph below). An automatic toll collection system known as e-tag has been adopted. Tolls were increased 10%–20% in March 2012, with Table E.9 showing the current toll structure.

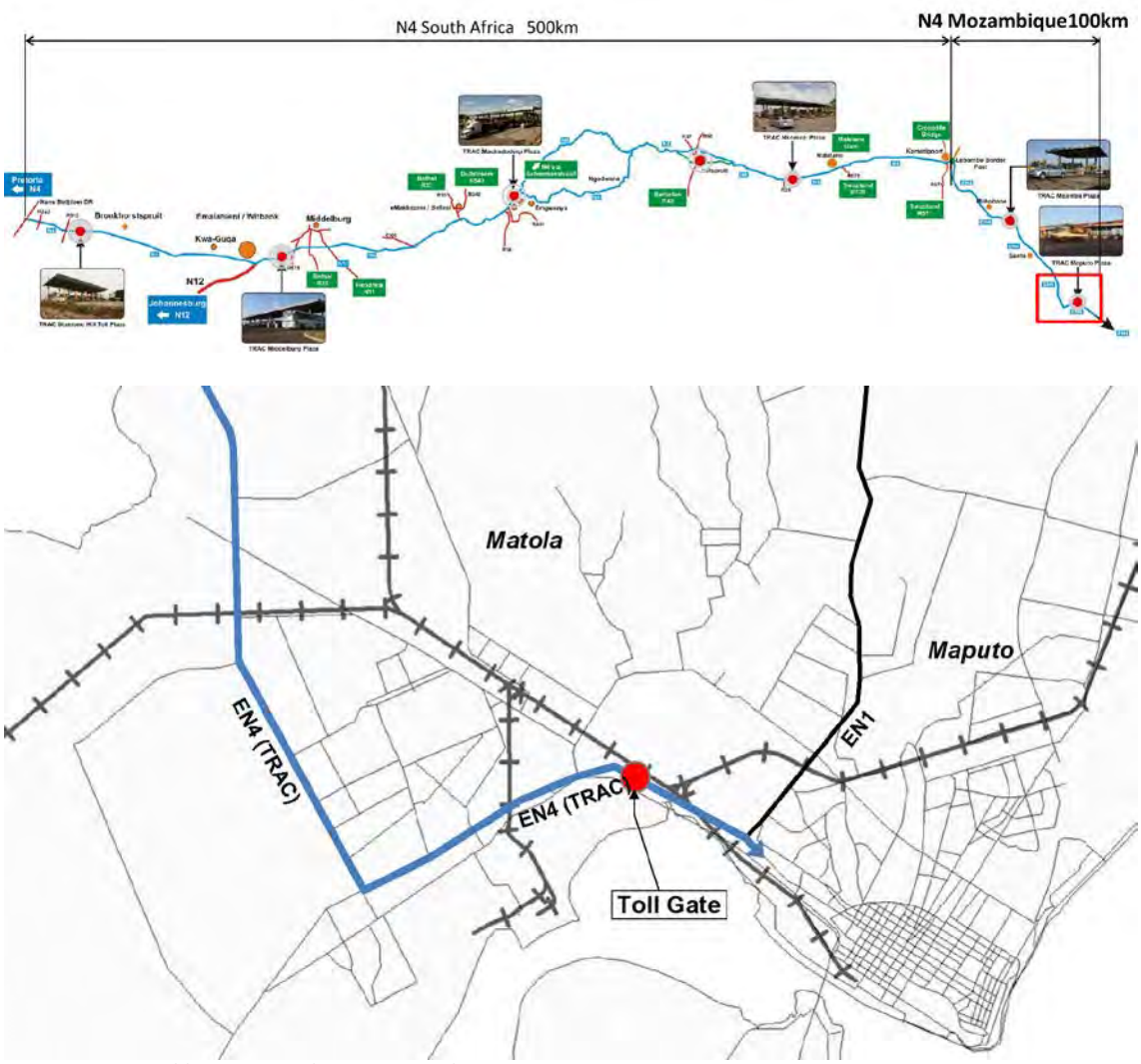
Although the N4 was constructed with four lanes, the Maputo–Matola section is heavily congested during peak periods at the toll gate and some signalized intersections with traffic of about 50,000 vehicles per day and no alternate routes. Figure E.7 presents a map of the N4 toll road.

The N4 Toll Gate

Table E.9: Current Toll Charges

Class	Maputo Toll Plaza	Moamba Toll Plaza
Class 1 (light vehicles)	MT 17.50 → 20.0	MT 95.0 → 105.0
Class 2 (medium heavy vehicles)	MT 58.00 → 70.0	MT 236.0 → 260.0
Class 3 (large heavy vehicles)	MT 116.00 → 140.0	MT 471.0 → 520.0
Class 4 (extra large heavy vehicles)	MT 174.00 → 200.0	MT 707.0 → 780.0

Source: Trans African Concessions



Sources: Trans African Concessions, JICA Project Team

Figure E.7: N4 Toll Road Map

(3) Major Road Network Conditions in Mozambique

The results of a countrywide road surface inspection conducted by ANE in 2009 are shown in Table E.10.

Table E.10: Surface Condition of Major Road Network in Mozambique

Condition	Pavement Km		Non-Pavement km							
			Total		Thoroughfare		Part Closed		Closed	
Good	3,698	(65%)	4,221	(17%)	3,648	(15%)	507	(2%)	66	(0%)
Fair	1,302	(23%)	8,501	(35%)	6,801	(28%)	1,432	(6%)	268	(1%)
Poor	649	(11%)	11,596	(48%)	3,311	(14%)	5,371	(22%)	2,914	(12%)
Total	5,649	(100%)	24,318	(100%)	13,760	(57%)	7,310	(30%)	3,248	(13%)

Source: ANE

E.2.2 Municipal (District) Road Network

(1) Maputo Municipal Roads

The Maputo municipal road network forms a grid in the central urban area. Although it has radial features toward the north, the network is not structured orderly in other parts of the city. The network is connected by major arterial roads linking districts and some of the key intersections are roundabouts.

The Maputo municipal road network is congested since the major arterial road network routes of the N1 and N4 traverse the western part of the area, with the blending of local and through traffic. Near the international airport, the road network extends to the north and south. However, there are traffic bottlenecks where the north-south arterial roads (Av. Julius Nyerere and Rua da Beira) cross.

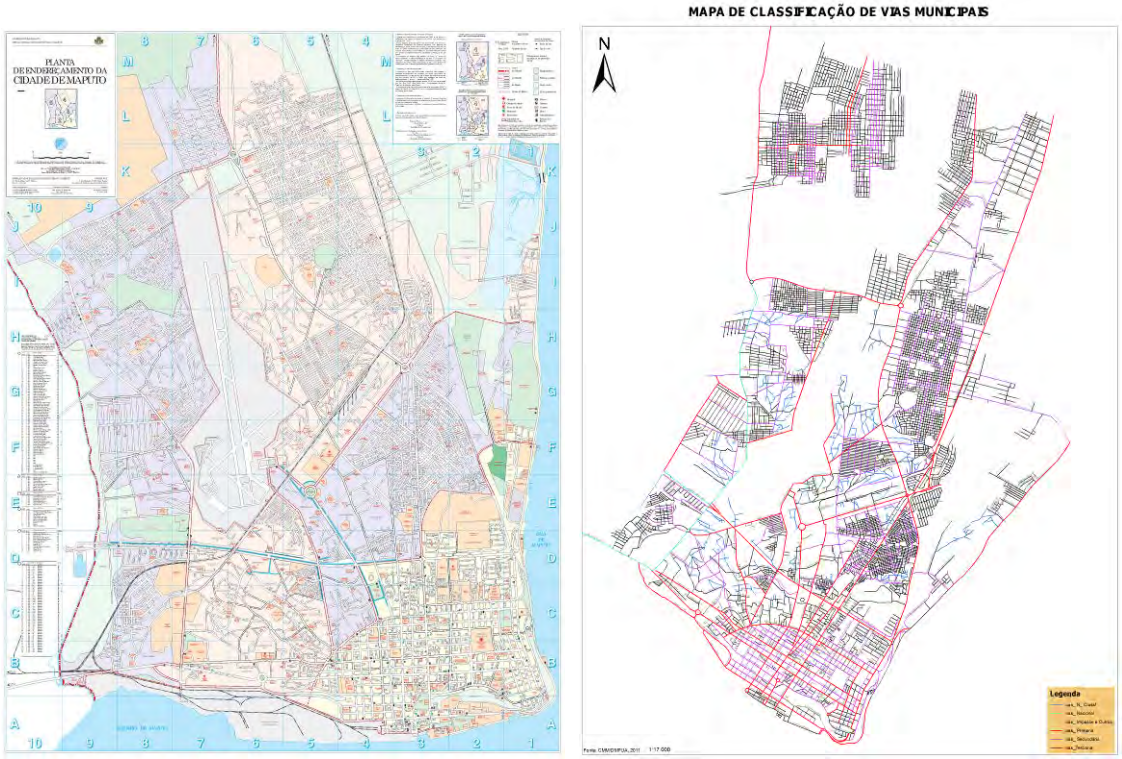
The overall length of the Maputo municipal road network is about 1,000 km, with 60%–70% of it paved in the central urban area. However, in the northern part of the region and the western airport area, less than 10% of roads are paved. Road maintenance (e.g., road cleaning, repair of potholes and sidewalks, ground leveling of unpaved roads) is funded under the municipal budget.

Table E.11 presents road lengths of the Maputo municipal network by feature and location, while Figure E.8 provides a network and classification map.

Table E.11: Road Lengths of the Maputo Municipal Network by Feature and Location

Feature	Kampfumu	Nlhamankulo	Kamaxakeni	Kamavota	Kamabukwana	Total (km)
Collector	33	3	14	14	10	74
Avenues (paved)	38	21	7	3	6	75
Streets (paved)	110	52	37	2	10	211
Avenues (unpaved)	3	5	26	28	24	85
Streets (unpaved)	53	55	118	130	201	557
Total	237	136	201	177	251	1,001
Paved network	181 (76%)	76 (56%)	58 (29%)	19 (11%)	26 (10%)	359 (36%)
Unpaved network	56 (24%)	60 (44%)	144 (71%)	158 (89%)	225 (90%)	642 (64%)

Source: Maputo Infrastructure Department



Source: Maputo Infrastructure Department

Figure E.8: Maputo Municipal Road Network and Classification Map

(2) Matola Municipal Roads

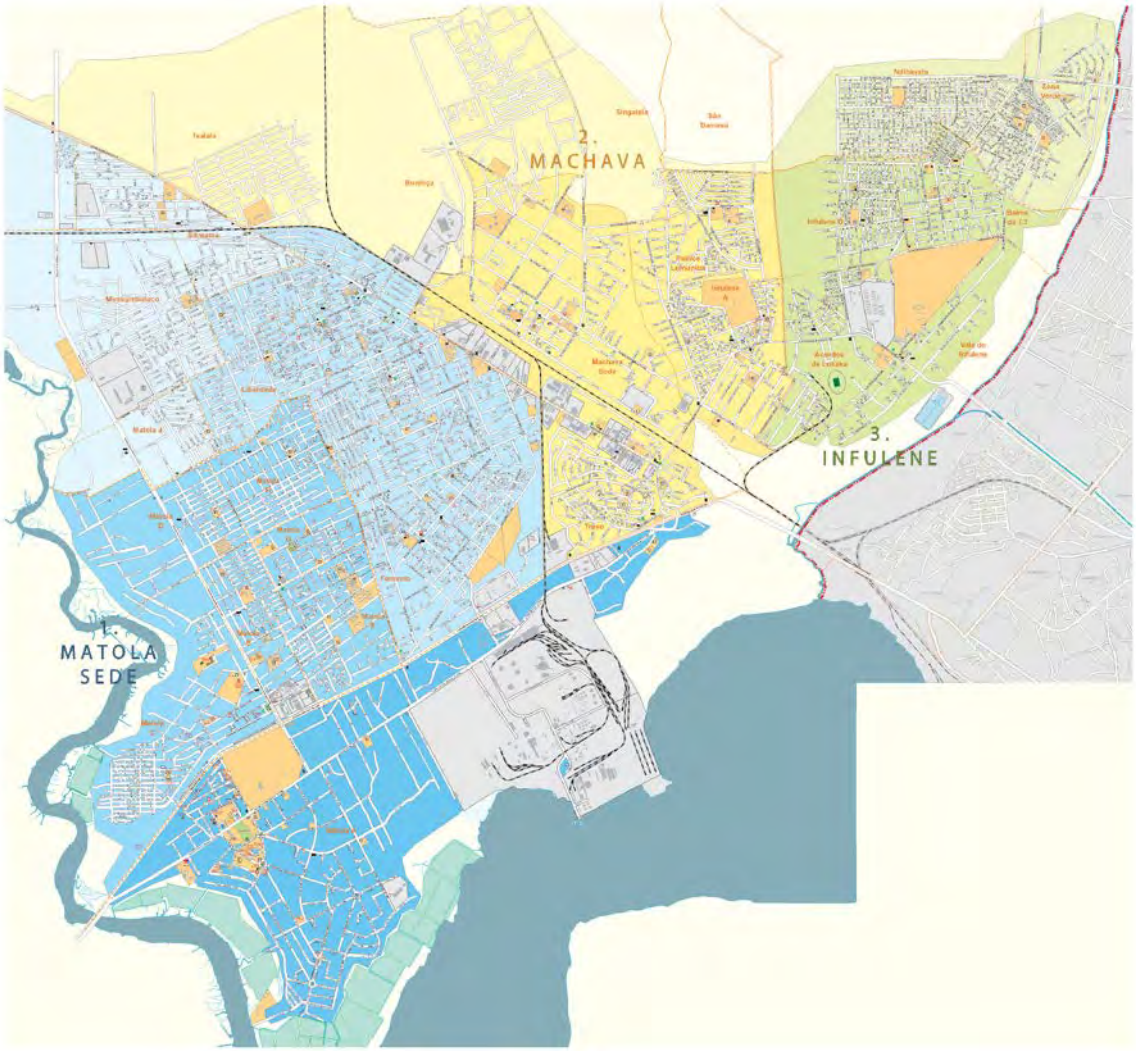
The Matola municipality comprises three districts. Each district and road network is divided by rail lines and topographical restrictions. In the western district, the road network is a grid and the topography is flat. In the eastern district, although many roads were developed, they are narrow and generally in poor condition, which restricts traffic volumes. In Infulene, vehicular traffic is difficult in about 70% of the network, with routes in good condition accounting for less than 10%. Chapa drivers went on strike because the condition of the T3, a major route, is in poor condition. In addition, Matola municipality previously had a standard road classification system (e.g., primary, secondary) but now its network is unclassified with no designated hierarchy.

Table E.12 presents road lengths of the Matola municipal network by feature and location, while Figure E.9 provides a network and classification map.

Table E.12: Road Lengths of the Matola Municipal Network by Feature and Location

Feature		Matola Sede	Machava	Infulene	Total
Pavement (km)	Paved	112.1	27.5	14.7	154.2
	Partial Pavement	15.4	12.0	0.4	27.8
	Unpaved	271.7	56.4	65.5	393.6
	Total	399.1	95.8	80.6	575.6
Condition	Passable	18%	19%	7%	17%
	Semi-passable	48%	37%	25%	43%
	Impassable	34%	44%	68%	40%

Source: Matola Infrastructure Department



Source: Matola Infrastructure Department

Figure E.9: Matola Municipal Road Network

(3) Marracuene District Roads

In the central area of Marracuene, the network consists of a grid, with some of the roads paved. The route connecting Maputo is largely via the N1. Although there are other routes, traveling by car on this particular road is difficult due to the unpaved surface and poor condition. Table E.13 sets out details on road lengths in Marracuene.

Table E.13: Road Lengths and Conditions in Marracuene District

Pavement (km)	Paved	35.3
	Unpaved	208.4
	Total	243.7
Condition	Good	14%
	Reasonable (Fair)	20%
	Poor	66%

Source: Marracuene Infrastructure Department

(4) Boane City Roads

Although there is a small road network in the central part of Boane, the roads are unpaved. Maputo and Matola are connected only through the N2. To travel between Boane and Catembe (Maputo), R200 via Bera-Vista is used. Table E.14 sets out details on road lengths in Boane.

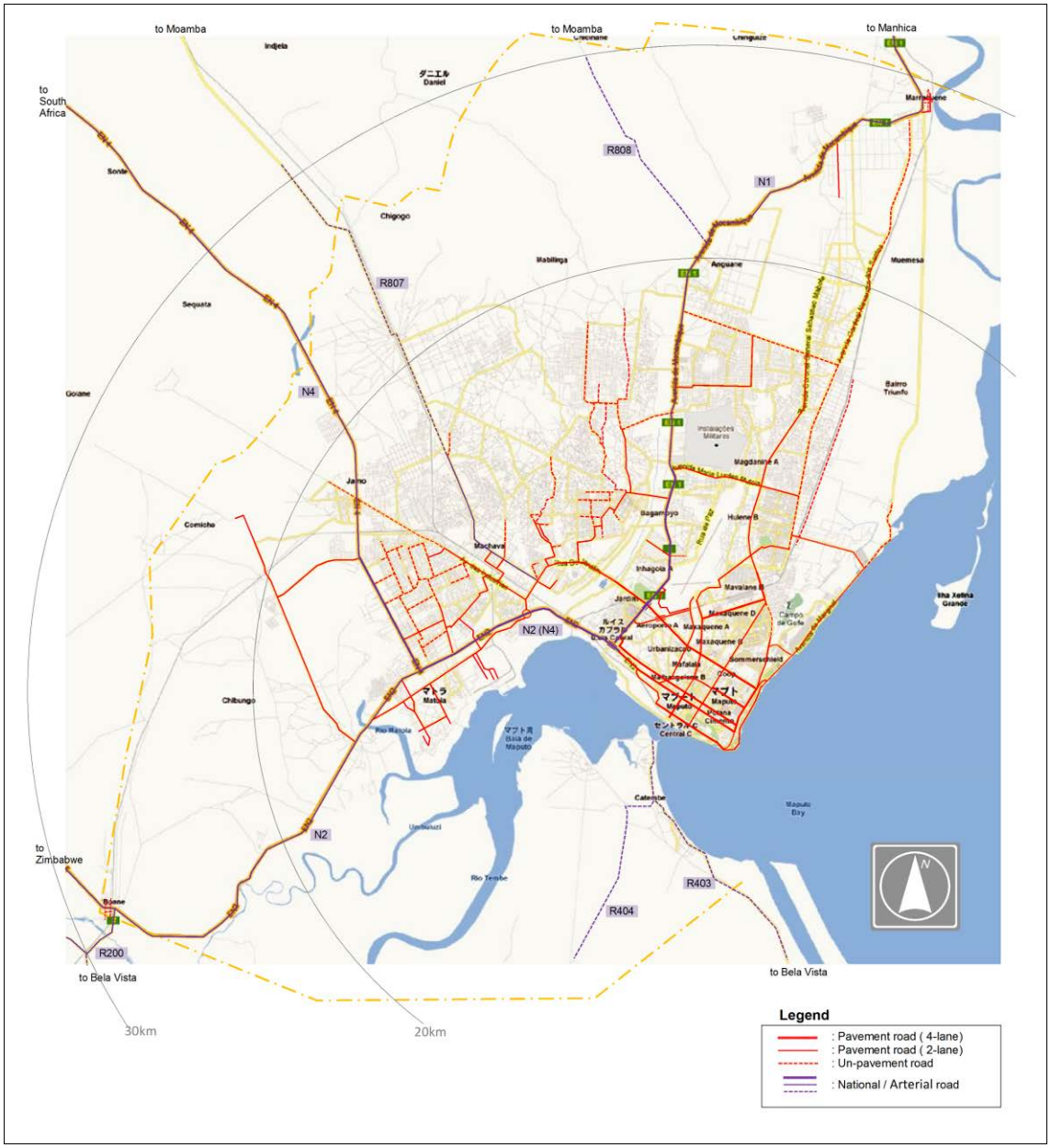
Table E.14: Road Lengths of Boane City

Pavement (km)	Paved	31.4
	Unpaved	161.2
	Total	192.6

Source: Boane Infrastructure Department

E.2.3 Existing Municipal (District) Road Network

Regarding the wider road network of local links in Greater Maputo, although there are many roads in residential areas, most are cul-de-sacs. There are only a few continuous routes in which through vehicle traffic is possible. In Matola, even the arterial roads are still insufficient to meet the existing traffic demand. Furthermore, since there are few routes connecting districts, traffic is concentrated along a number of limited routes. In Marracuene and Boane, the national road is the only route that connects these districts with Maputo or Matola. Figure E.10 shows the existing arterial road network in the Greater Maputo area including unpaved roads in which vehicular traffic is possible.



Source: JICA Project Team

Figure E.10: Main Arterial Road Network of the Greater Maputo Area

E.2.4 Road Disasters

In Greater Maputo road disasters mainly occur due to heavy rain. Other types of road disasters include landslides, weakening of the road base, bridge collapses, and coastal erosion. The N1 in Marracuene collapsed due to flash flooding in February 2012. Considering that the main cause of this disaster was heavy rain, it would be desirable to develop a drainage system capable of processing rainfall properly and a stable road structure to prevent or reduce the severity of such occurrences. Examples of road disasters follow.

Av. Julius Nyerere Landslide in 1998: Earth materials were removed and rehabilitation and construction have started.

Connection Road in Maputo and Marracuene: The truck is stranded due to weakness of the road surface.

Connection Road in Maputo and Marracuene: The bridge collapsed due to flooding and has since been reconstructed.

R200 connecting Boane and Vela Vista: The bridge over the Umbulzi collapsed in January 2012.

Coastal Road in Eastern Maputo: The coastal shore protection has collapsed, narrowing the right of way.

The southern portion of the Maputo urban area: The road and the sidewalk were flooded due to a concentration of rainwater in the lowlands.

Source: JICA Project Team

Figure E.11: Examples of Road Disasters

E.2.5 Review of Maputo Municipal Road Development Master Plan (2001)

The Maputo Municipal Council formulated a development plan in 2001 that assimilated the findings of a JICA-assisted Maputo Municipal Road Development Master Plan completed in 2001. The Municipality's 2001 plan was reviewed in 2008 to determine a program for road construction, improvement, rehabilitation, and maintenance. Priority was given to the road network in urban districts and the arterial roads connecting urban districts and suburban areas. Table E.15 shows the progress of implementation of the 2001 road development master plan, Table E.16 provides more details on 2001 plan, and Figure E.12 presents the route map of the 2001 road development master plan.

Table E.15: Progress of Implementation of the Road Development Master Plan of 2001

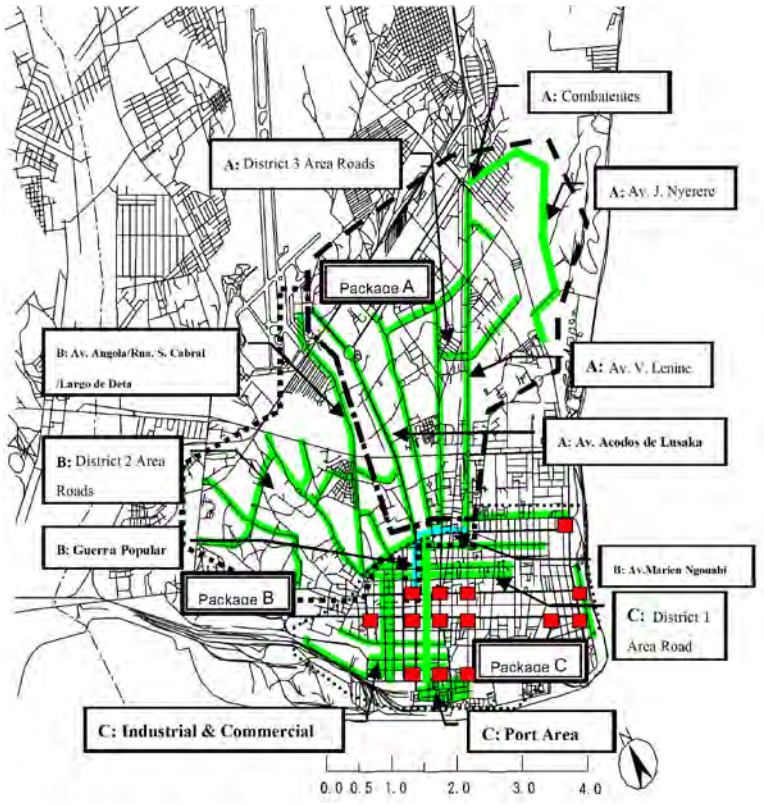
Priority	Package	Complete (km)	Incomplete (km)	Total (km)	Percentage Complete
1st	Package C	18.6	---	18.6	100%
2nd	Package A	6.3	11.6	17.9	35%
3rd	Package B	1.6	13.4	15.0	11%
	Total	26.5	25.0	51.5	51%

Source: Maputo Infrastructure Department and JICA, *The Study on the Master Plan for the Road Development of Maputo*, 2001

Table E.16: JICA Proposed Maputo Municipal Road Development Master Plan of 2001

Priority	Proposed Roads
1st (Package C)	• Rehabilitation of pavement and drainage of Industrial and Commercial Area Roads (6.03 km) • Rehabilitation of pavement and drainage of Port Area Roads (3.9 km) • Rehabilitation of pavement and drainage on District 1 Area roads (total length = 8.7 km) • Improvement of Bus bays and terminals (23)
2nd (Package A)	• Construction of the bypass missing link of Av. J. Nyerere (5.6 km) • Improvement of Av. V. Lenine (Bus-bay, Intersection) • Improvement of Av. A. Lusaka (2.8 km) • Construction of the bus terminal at Combatentes Plaza • Rehabilitation of pavement and drainage on District 3 Area Roads (9.5 km)
3rd (Package B)	• Widening of Av. G. Popular (0.7 km) • Improvement of Av. Angola (3.1 km) and S. Cabral/Largo de Deta (0.6 km) • Improvement and widening of Av. M. Ngouabi (1.9 km) • Rehabilitation of pavement and drainage on District 2 Area Roads (8.7 km) • Improvement of intersections in the central business district (14 intersections)

Source: JICA, *The Study on the Master Plan for the Road Development of Maputo*, 2001



Source: JICA, *The Study on the Master Plan for the Road Development of Maputo*, 2001

Figure E.12: Route Map of the Road Development Master Plan of 2001

E.2.6 Ongoing Road Development Projects

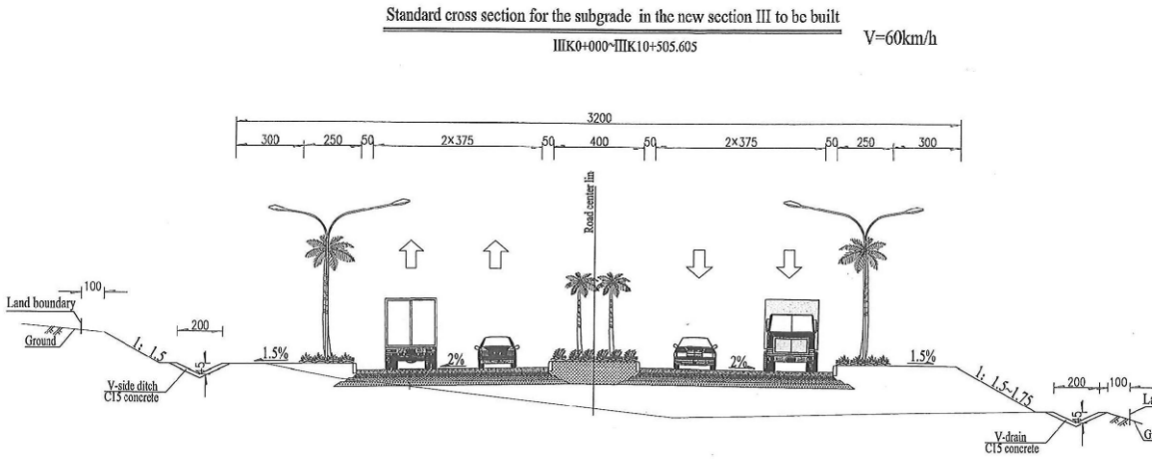
(1) Ring Road Project

The Ring Road Project, a major arterial road, is to be developed in the northern suburban areas about 20 km from the centers of Maputo and Matola municipalities. The four-lane arterial road will have a design speed of 60–80 kph, and will serve as a bypass allowing motorists to avoid the urban area by connecting the existing N1 and N4. The route is divided into six sections and has a total length of 74 km. The ring road will be a toll road. Sidewalks, level crossings, and an access-controlled section at the intersection with N1 are included. The project was proposed by the China Road and Bridge Corproation, with the implementing (project management) agency to be the publicly owned Empresa de Desenvolvimento de Maputo Sul (Maputo-Sul Development Company). The estimated construction cost is USD 315 million, with financing from a loan from the Export-Import Bank of the People's Republic of China and the Government of Mozambique. Implementation is through the design-build method. Construction started in October 2012 and the construction period is about 30 months. Table E.17 presents details of the Ring Road Project, while Figure E.13 sets out some project highlights.

Table E.17: Ring Road Project

	Origin/Destination	Extension	Width (Lanes)	Design Speed	Remarks
I	• Radisson Hotel • Bridge of the Costa del Sol	6.3 km	32 m (4)	60 km/h	With sidewalks
II	• Bridge of the Costa del Sol • Chiango	19.9 km	28 m (4)	80 km/h	
III	• Chiango • Zinpeto National Stadium	10.5 km	32 m (4)	60 km/h	With sidewalks
IV	• Marracuene • Zinpeto National Stadium	15.5 km	26.5 m (4)	80 km/h	
V	• Zinpeto National Stadium • Bairro Tchumene	16.3 km	28 m (4)	80 km/h	
VI	• Machava • June 16 Square	5.5 km	21 m (4)	50 km/h	
	Total	74.0 km			

Source: Presentation video prepared by China Road and Bridge Corporation



Source: Presentation video and drawing prepared by China Road and Bridge Corporation

Figure E.13: Ring Road Route and Images

(2) Catembe Bridge Project

The proposed Catembe Bridge Project, which crosses Maputo Bay, will connect Maputo and Catembe municipalities. The project implementing agency is Maputo-Sul. The project is to consist of a long span bridge, connection road, and development of the KaTembe residential area by the BETAR Group. The construction cost is estimated to be USD 725 million, with financing from a loan from the Export-Import Bank of the People's Republic of China and the province of Maputo.

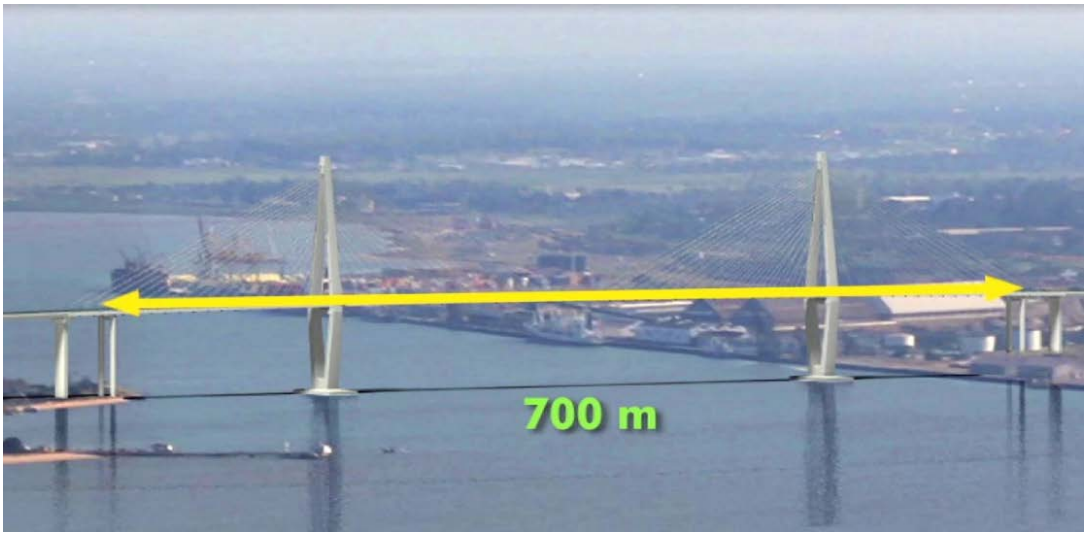
The cable-stayed bridge will be 700 m long, with a central span of 350 m, and a main tower height of 130 m. Although the bottom girder clearance is planned to be 57 m in consideration of large container ships, since the Catembe Bridge Project is near the Maputo urban area, issues

related to the concentration of new traffic and connecting routes require resolution. Table E.18 summarizes the features of the Catembe Bridge Project, while Figure E.14 illustrates the project.

Table E.18: Summary of Catembe Bridge

Name	**Catembe Bridge (Provisional name)**
Implementing agency	Empresa de Desenvolvimento de Maputo Sul
Bridge type	Cable-stayed
Bridge length/center span	L= 700 m / l= 350 m
Main tower height/clearance	H = 130 m/h= 57 m
Approach road structure	Viaduct type North side: 980 m, South side: 1,020 m

Source: Empresa de Desenvolvimento de Maputo Sul



Source: Empresa de Desenvolvimento de Maputo Sul

Figure E.14: Catembe Bridge Project Images

(3) Rehabilitation of Av. Julius Nyerere

Av. Julius Nyerere is a north-south, primary road in Maputo. In 1998, a landslide heavily damaged the road, making it difficult for traffic. To rehabilitate the damaged road, ProMaputo planned to construct two-lane roads of about 3.6 km. The rehabilitation consists of road ditches and a pedestrian overpass, which also functions as a crossing channel and is planned between the divided areas. The rehabilitation works started in March 2012 and were scheduled to be completed in early 2013. The estimated construction cost is USD 10 million, which is funded by ProMaputo. Figure E.15 illustrates the location and rehabilitation of Av. Julius Nyerere.

Source: JICA Project Team

Figure E.15: Location and Rehabilitation of Av. Julius Nyerere

E.3 Road Network Project

E.3.1 Road Network Long List

Table E.19 presents a long list of road network projects.

Table E.19: Long List of Road Network Projects

No.	Project Component	Route	Project Type	Length (km)	Lane Number	Width (m)	Construction Cost (USD million)	Remarks
1. Maputo North-South Major Arterial Roads								
1.1	Airport Side North-South Route New Construction	Extension of Rua do Mercado	N	4.8	2	12.0	6.0	
1.2	Julius Nyerere Rehabilitation	Julius Nyerere (South)	F	3.6	4	26.3	N/A	Ongoing
1.3	Julius Nyerere Improvement	Julius Nyerere (North)	N/A	N/A	N/A	N/A	N/A	Missing number for BRT (9.2)
1.4	Eastern Airport North-South Route Improvement	Rua da Igreja	P	10.3	2	12.0	13.1	
1.5	Maputo Central Urban Area Major Arterial Road Four-Lane Widening	Av. Vladimir Lenine	F	6.2	4	27.0	14.2	
1.6	Maputo-Marracuene Connection Road Improvement (A)	Av. Cardeal Alexandre dos Santos Rua 4.665	W,P	19.3	2	15.5 12.0	28.6	
1.7	Maputo-Marracuene Connection Road Improvement (B)	Extension of Av. Coronel General Sebastiao Mabote, Extension of Av. Coronel General Sebastiao Mabote (Northern)	W,N	6.7	2	15.5	10.0	

No.	Project Component	Route	Project Type	Length (km)	Lane Number	Width (m)	Construction Cost (USD million)	Remarks
2. Ring Road and Major East-West Arterial Roads								
2.1	Outer Ring Road New Construction	I: Radisson Hotel - Costa del Sol Bridge II: Costa del Sol Bridge–Chiango III: Chiango - Zinpeto National Stadium IV: Marracuene - Zinpeto National Stadium V: Zinpeto National Stadium - Bairro Tchumene VI: Machava - June 16 Square	F,N	74.0	4	21.0 - 32.0	N/A	Ongoing
2.2	Inner Ring Road New Construction	Extension of New Inner Ring Road Rua Mário Coluna	N,W	5.2	2	15.5	7.9	BRT (9.7)
2.3	Matola Av. Eduardo Mondlane Widening	Av. Eduardo Mondlane/ Matola	N/A	N/A	N/A	N/A	N/A	Missing Number for BRT (9.4)
2.4	Boane Outer Ring Road New Construction and EN2 Widening	Extension of Ring Road EN2	N,F	30.6	4	24.0 28.0	104.6	
3. Western Matola Industrial Area Major Arterial Roads								
3.1	Industrial Road Improvement	Rua 21.115, Rua 21.142 Av. das Industrias R807 (Av. Josina Machel)	N,P	11.6	2	16.0	17.6	
3.2	EN4 Widening	EN4 (North)	F	6.9	4	28.0	15.9	
4. National Roads and Other Major Arterial Roads								
4.1	KaTembe Bridge Development	Maputo/KaTembe/ Ponta do Ouro	B	2.7	4	21.4	N/A	Ongoing
4.2	EN1 Widening (South)	EN1	F	6.5	4	28.0	N/A	Completed
4.3	EN1 Widening (North)	EN1	N/A	N/A	N/A	N/A	N/A	Missing Number for BRT (9.3)
4.4	New EN1 Bypass Construction	New EN1 Bypass	N	8.3	4	22.0 (50.0)	153.7	
4.5	Boane Bridge Reconstruction	N200 (Boane Bridge)	B	0.6 (0.15)	2	12.0	10.6	
5. District Arterial Roads and Main Streets								
5.1	New Construction and Improvement of Nhlamankulu Area Route	Extension of Rua do Zambeze Rua do Zambeze Rua do Chamanculo	N,P	2.8	2	8.0	2.9	
5.2	Eastern Airport Urban Area Route Improvement	Av. Da Malhangalene Rua 1º de Maio Rua 3.385 Rua Tenente General Fernando Honwana, Rua José Carlos Lobo	W	6.0	2	12.0 8.0	7.5	

No.	Project Component	Route	Project Type	Length (km)	Lane Number	Width (m)	Construction Cost (USD million)	Remarks
5.3	Northern Maputo East-West Route Improvement	Extension of Av. Nelson Mandela	W	2.6	2	12.0	3.2	
5.4	Infulene Urban Area Road Improvement	Rua Francisco N.Matsinhe Rua 31.236	P	2.2	2	15.5 22.0	4.0	
5.5	New Construction and Improvement of Road in the Machava Urban Area	Rua Rafael Maguni Rua 31.199, Av. Filipe Samuel Magaia Av. 3 de Fevereiro	W,N	12.1	2	15.5	18.1	
5.6	New Construction and Improvement of Road in the Matola Suburban Area	(Infulene Middle District, North-south Route) (Infulene Middle District, Peripheral Route) (Machava Central District, North-south Route) (Machava Central District, East-west Route)	W	26.5	2	15.5	39.6	
5.7	Matola-Sede Urban Arterial Road Improvement	Av. Joaquim Chissano/ Matola Av. Maestro Justino Chemane	P	5.8	2	12.0 15.5	8.3	
5.8	KaTembe R403 Improvement	R403	P	10.4	2	15.5	15.6	
6. Distributor Roads								
6.1	Maputo Central Urban Area Peripheral Road Four-Lane Widening	Av. da Marginal	F	4.3	4	27.0	12.2	
6.2	Western Airport Area Route Improvement	Rua da Paz Rua de São Paulo Extension of Rua de São Paulo Rua 5.576, Rua 5.650	W,P,N	7.1	2	15.5 12.0	10.1	
6.3	New Construction and Improvement of Greenbelt Road	Extension of Rua das Quintas Extension of Rua das Agricultores Extension of Rua das Zonas Verdes	N	6.3	2	12.0	8.0	
6.4	Matola Power Cable Line Extension Road New Construction	New Road (Power Cable Line)	N	3.7	2	(100)	7.7	
7. District Connection Roads								
7.1	New Construction and Improvement of Machava -Maputo Connection Road	Extension of Rua 5.036 Extension of Rua 5.037	W,N	3.5	2	15.5 12.0	7.4	
7.2	New Construction and Improvement of Infulene-Maputo Connection Road	Rua 5.260 Rua 5.315 Rua 31.286	P,W,N	5.7	2	15.5 12.0	8.0	
7.3	Northern Infulene-Maputo Connection Road Improvement	Rua de Macute (Greenbelt Crossroad)	P,W	6.6	2	8.0 12.0	12.2	
7.4	Exclusive Bus Road of Maputo-Matla New Construction	Maputo-Matola Railway-side	N	7.2	2	8.0	20.8	

No.	Project Component	Route	Project Type	Length (km)	Lane Number	Width (m)	Construction Cost (USD million)	Remarks
8. Arterial Roads for Land Development								
8.1	Costa do Sol Area Road Network New Construction for District Development	Rua 4.280, Rua 4.664 Extension of Rua do Rio Inhandiara, Rua 4.685, Rua 4.662, Rua 4.342	N	11.8	2	15.5 12.0	17.6	
8.2	Northern Matola Area Road New Construction for District Development	Northern Matola North-south Road Northern Matola East-West Road R808	W,N,P	51.5	2	15.5	77.0	
8.3	Marracuene East-West Route New Construction	Marracuene East-West Route	N	5.3	2	15.5	8.0	
8.4	Boane Connection Road New Construction for District Development	Boane-Matola Rio Route	N	19.6	2	15.5 12.0	46.4	
8.5	Boane-KaTembe Connection Road New Construction for District Development	Boane-KaTembe Route, R404	N	25.7	2	12.0	140.2	
9. Improvements for BRT								
9.1	BRT Maputo Central Urban Line	Av. Eduardo Mondlane	P	2.6	BRT+4	40.0	5.9	
9.2	BRT Maputo North-South Line	Av. Guerra Popular Av. Acordos de Lusaka Av. F.P.L.M Av. Julius Nyerere	P,W	12.4	BRT+4	34.5 28.5	25.7	1.3
9.3	BRT EN1 Line	EN1 (South) EN1 (North)	P	15.4	BRT +2 (4)	25.5 28.5	28.1	4.3
9.4	BRT Maputo Machava East-West Line	Av. Joaquim Chissano Av. Eduardo Mondlane/ Matola	P,W	10.4	BRT+4	40.0 28.5	27.6	2.3
9.5	BRT Maputo Matola Sede Line	Av. Setembro, Av. Organização das Nações Unidas New Ring Road VI EN2 (Matola)	P,N	14.0	BRT +4 (6)	28.5 24.5 39.5	55.1	
9.6	BRT Matola EN4 Line (South)	EN4 (South)	P	7.9	BRT+4	34.5	19.9	
9.7	BRT Inner Ring Road Line	Av. Maria de Lurdes Mutola New Road (Zona Verde, Power Cable Line, R807, EN4)	P,N	19.3	BRT+4	28.5 100.0	42.7	2.2

Abbreviations: B = bridge, F = 4-laning, N = new construction, N/A = not applicable, P = paving, W = widening
Note: The costs shown for improving BRT is only for road widening and does not include BRT roads.
Source: JICA Project Team

E.3.2 Priority Project Selection

Table E.20 presents an evaluation of the priority of the road projects.

Table E.20: Evaluation of Road Projects (1/2)

Project Component	No	Project Name	Length (km)	Lane Number	Importance			Technical Effect		
					Traffic Volume	Area	25%	Traffic Function	Space function	20%
1. Maputo North-south Major Arterial Road	1.1	Airport Side North-south Route New Construction	4.8	2	Low	Urban	10	Medium	Low	8
	1.4	Eastern Airport North-south Route Improvement	10.3	2	Medium	Urban	20	Medium	Low	8
	1.5	Maputo Central Urban-area Major Arterial Road Four-lane Widening	6.2	4	High	Urban	25	Medium	Low	8
	1.6	Maputo - Marracuene Connection Road Improvement (A)	19.3	2	Medium	Urban	20	High	High	20
	1.7	Maputo - Marracuene Connection Road Improvement (B)	6.7	2	Low	Suburban	5	Medium	Low	8
2. Ring Road and East-west Major Arterial Road	2.2	Extention of Inner Ring Road	5.2	4	Medium	Urban	20	Medium	High	12
	2.4	Boane Outer Ring Road New Construction and EN2 Widening	30.6	4	Medium	Suburban	15	Low	Low	4
3. Western Matola Industrial Area Major Arterial Road	3.1	Industrial Road Improvement	11.6	2	Medium	Suburban	15	High	Low	16
	3.2	EN4 Widening	6.9	4	High	Suburban	20	Medium	Low	8
4. National Road and Other Major Arterial Road	4.4	New EN1 Bypass Construction	8.3	4	High	Urban	25	High	Low	16
	4.5	Boane Bridge Reconstruction	0.6	2	Low	Suburban	5	Low	Low	4
5. District Arterial Road and Main Street	5.1	New Construction and Improvement of Nhlamankulu Area Route	2.8	2	Medium	Urban	20	Medium	Low	8
	5.2	Eastern Airport Urban Area Route Improvement	6.0	2	Low	Urban	10	Medium	Low	8
	5.3	Northern Maputo East-west Route Improvement	2.6	2	Low	Urban	10	Low	High	4
	5.4	Infulene Urban Area Road Improvement	2.2	2	Medium	Urban	20	Low	High	4
	5.5	New Construction and Improvement of Road in the Machava Urban Area	12.1	2	High	Urban	25	Medium	High	12
	5.6	New Construction and Improvement of Road in the Matola Suburban Area	26.5	2	Medium	Suburban	15	Medium	High	12
	5.7	Matola-Sede Urban Arterial Road Improvement	5.8	2	Medium	Urban	20	Low	High	4
	5.8	KaTembe R403 Improvement	10.4	2	Low	Suburban	5	Medium	High	12
6. Detour Road for Distribution	6.1	Maputo Central Urban-area Peripheral Road Four-lane Widening	4.3	4	Low	Suburban	5	Medium	Low	8
	6.2	Western Airport Area Route Improvement	7.1	2	Low	Urban	10	Medium	Low	8
	6.3	New Construction and Improvement of Green-belt Road	6.3	2	Medium	Urban	20	Medium	Low	8
	6.4	Matola Power Cable Line Extension Road New Construction	3.7	2	Medium	Suburban	15	Low	Low	4
7. Districts Connection Road	7.1	New Construction and Improvement of Machava -Maputo Connection Road	3.5	2	Medium	Urban	20	High	Low	16
	7.2	New Construction and Improvement of Infulene -Maputo Connection Road	5.7	2	Medium	Urban	20	High	Low	16
	7.3	Northern Infulene - Maputo Connection Road Improvement	6.6	2	Low	Suburban	5	Medium	High	12
	7.4	Exclusive Bus Road of Maputo-Matla New Construction	7.2	2	Medium	Urban	20	High	Low	16
8. Arterial Road for Land-use Development	8.1	Costa do Sol Area Road Network New Construction for District Development	11.8	2	Low	Urban	10	Medium	High	12
	8.2	Northern Matola Area Road New Construction for District Development	51.5	2	Low	Suburban	5	Low	High	4
	8.3	Marracuene East-west Route New Construction	5.3	2	Low	Suburban	5	Low	Low	4
	8.4	Boane Connection Road New Construction for District Development	19.6	2	Medium	Suburban	15	Low	High	4
	8.5	Boane - KaTembe Connection Road New Construction for District Development	25.7	2	Low	Suburban	5	Low	Low	4

Table E.20: Evaluation of Road Projects (2/2)

No	Construction Cost			Environmental Impact			Consistency		Total	Ranking based on Scoring	Proposed Term	Remarks
	Cost Total	Project Cost	20%	100%	Resettlement	25%	Consistency	10%	100%			
1.1	6.0	Low	16	50	High	10		0	44	23	Medium	
1.4	13.1	Medium	12	13	Medium	15		0	55	11	Medium	
1.5	14.2	Medium	12	280	Very High	5	Detour for BRT	6	56	10	Medium	
1.6	28.6	Medium	12	41	High	10		0	62	6	Short	
1.7	10.0	Low	16	7	Low	20		0	49	20	Medium	
2.2	7.9	Low	16	108	Very High	5		0	53	16	Medium	
2.4	104.6	Very High	4	13	Medium	15		0	38	29	Long	
3.1	17.6	Medium	12	40	High	10	For Industry	6	59	9	Short	
3.2	15.9	Medium	12	0	Very Low	25		0	65	2	Short	
4.4	153.7	Very High	4	100	High	10	For BRT	10	65	2	Short	
4.5	10.6	Medium	12	0	Very Low	25	Urgency	6	52	18	Short	Urgency
5.1	2.9	Very Low	20	190	Very High	5		0	53	16	Medium	
5.2	7.5	Low	16	45	High	10		0	44	23	Medium	
5.3	3.2	Very Low	20	20	Medium	15		0	49	21	Medium	
5.4	4.0	Very Low	20	10	Low	20		0	64	5	Short	
5.5	18.1	Medium	12	238	Very High	5		0	54	13	Medium	
5.6	39.6	High	8	88	High	10		0	45	22	Medium	
5.7	8.3	Low	16	0	Very Low	25		0	65	2	Short	
5.8	15.6	Medium	12	0	Very Low	25		0	54	13	Medium	
6.1	12.2	Medium	12	3	Very Low	25		0	50	19	Medium	
6.2	10.1	Medium	12	90	High	10		0	40	26	Medium	
6.3	8.0	Low	16	33	High	10		0	54	13	Medium	
6.4	7.7	Low	16	8	Low	20		0	55	11	Medium	
7.1	7.4	Low	16	80	High	10		0	62	6	Short	
7.2	8.0	Low	16	45	High	10		0	62	6	Short	
7.3	12.2	Medium	12	22	Medium	15		0	44	23	Medium	
7.4	20.8	Medium	12	15	Medium	15	For Railway	10	73	1	Short	
8.1	17.6	Medium	12	109	Very High	5		0	39	28	Medium	
8.2	77.0	High	8	25	Medium	15		0	32	32	Long	
8.3	8.0	Low	16	20	Medium	15		0	40	26	Long	
8.4	46.4	High	8	35	High	10		0	37	31	Long	
8.5	140.2	Very High	4	0	Very Low	25		0	38	29	Long	

E.4 Proposed Geometric Design

E.4.1 Road Classification

The classification of local (i.e., municipal and district) roads includes major arterial roads (primary), arterial roads (secondary), local distributor roads (tertiary), and access streets, which collectively comprise a functional road network. As a basic premise, routes should connect origins and destinations continuously, without "skipping" a classification. Table E.21 shows the relationship between local roads and ANE roads. Details on each classification of local roads follow.

Table E.21: Relationship between Local Roads and ANE Roads

National Road (ANE)	**Primary** 60 – 100 km/h (N1, N2, N4)	**Secondary** 60 – 80 km/h (N200, N201)	**Tertiary** 40 – 60 km/h (R400, R403)	**Vicinal** **Non Classification**
Local Road (Municipal and District Road)	**Major Arterial** 60 – 80 km/h	**Arterial** 40 – 60 km/h	**Local Distribution** 20 – 40 km/h	**Access Street**

Major arterial (local primary) roads in a broad sense form the urban framework, connecting to national roads, districts, and main public facilities. The link length is usually about 10–30 km. Narrow, existing roads and/or roads in poor condition can be considered for upgrading to major arterial roads in the future.

Arterial (local secondary) roads in a broad sense are for entering/exiting districts connected with a major arterial road. The link length is usually about 3–10 km, with 2-4 lanes. ane number is 2 to 4. Narrow, existing roads and/or roads in poor condition can be considered for upgrading to arterial roads in the future.

Local distributor (tertiary) roads are usually of 1–2 lanes. Through traffic should be excluded.

E.4.2 Road Widths

(1) Lane and Shoulder Widths

Lane width should be based on ANE's design standards, which are equivalent to the local classification. The standard lane width is 3.25 m (and greater than 3.5 m for roads with heavy truck traffic).

Shoulder widths should also based be an ANE's design standard, which is equivalent to the local classification. The standard shoulder width is 1.5 m in consideration of car parking requirements. Also, chapa stops and vehicular traffic should be taken into consideration.

Figure E.16 presents additional details on vehicle and shoulder widths.

Vehicle Width

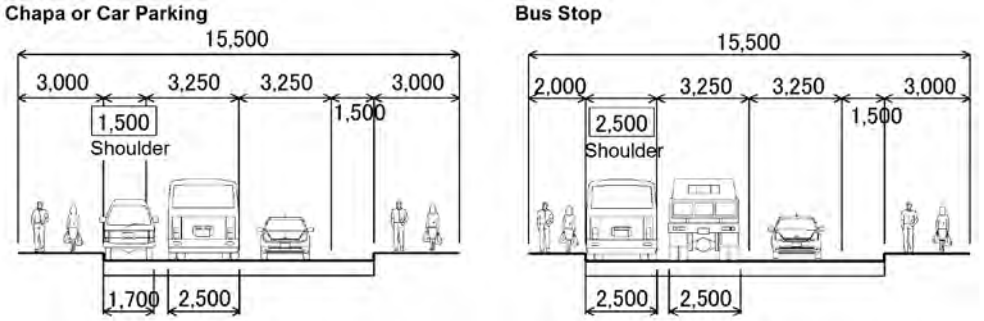
W = 2.5 m (Japan, EC Directive)
W = 2.44 m or 2.74 m (USA)

ISO Container Standard ISO

40 ft: L = 12,192 mm, W = 2,438 mm
H = 2,438 mm, W = 30,480 kg

Existing Special Vehicle

W = 3.2 m

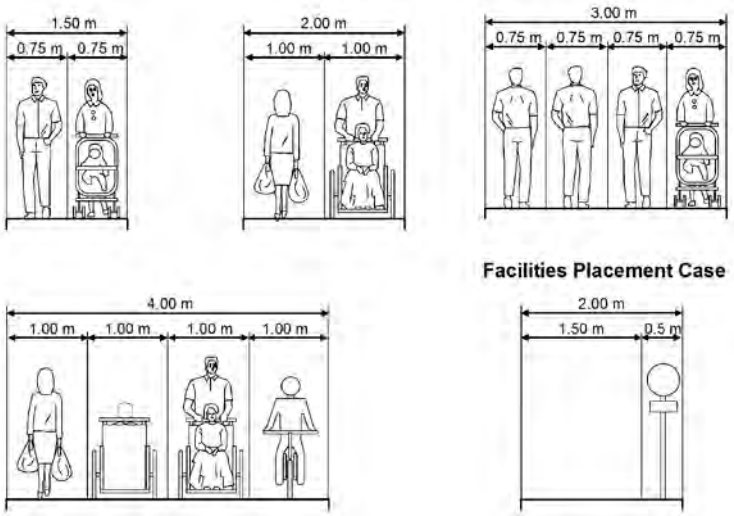


Source: JICA Project Team

Figure E.16: Vehicle and Shoulder Widths

(2) Sidewalk Widths

The sidewalk width should be more than 2.0 m, although if unavoidable, it can be reduced to 1.5 m. In urban areas, the desirable sidewalk width is more than 3 m. On an urban road with heavy pedestrian traffic in a commercial zone, wider sidewalks are desirable. Also, the sidewalk width should be sufficient for road facilities (e.g., traffic signs, planted trees). Figure E.17 provides additional details.

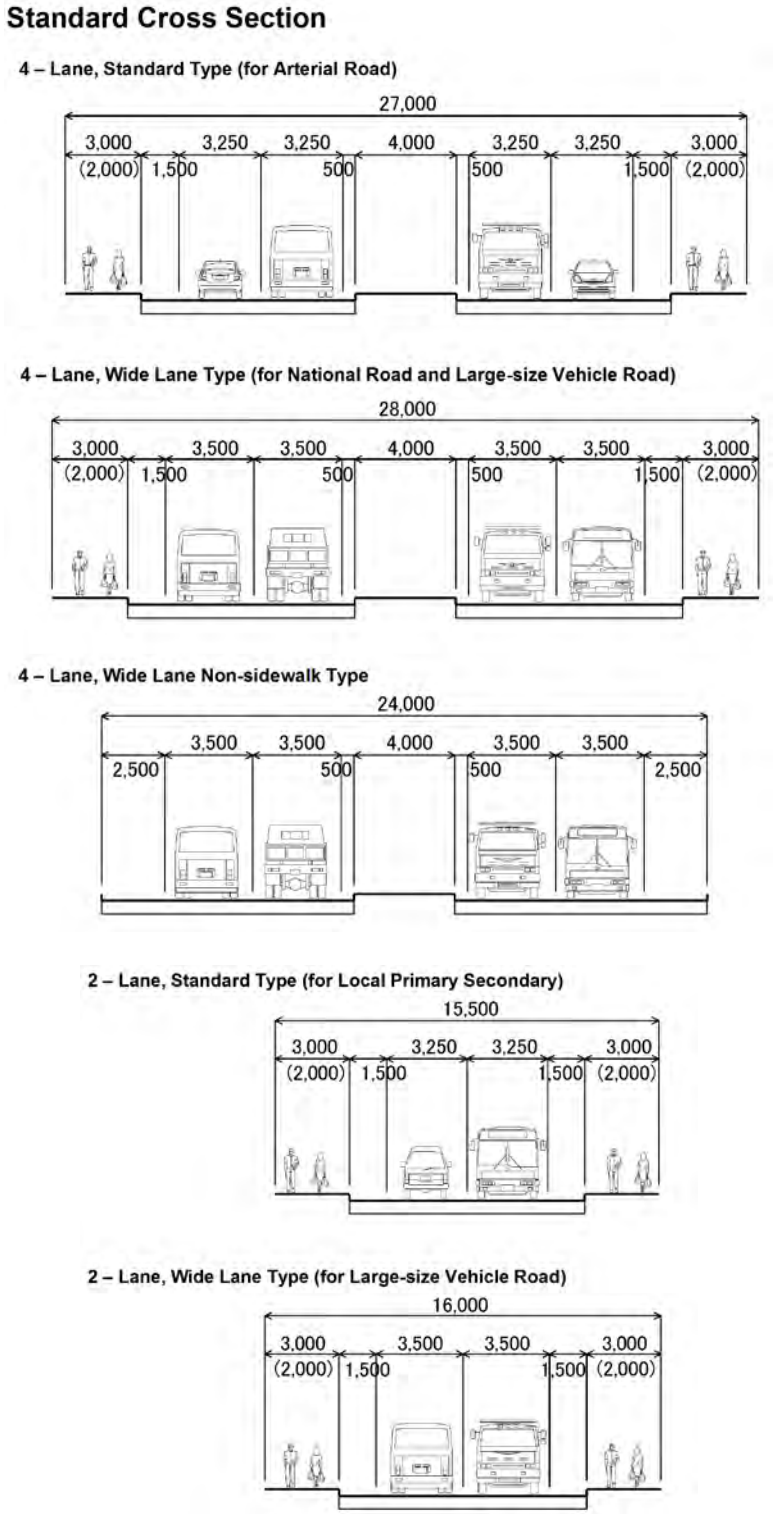


Source: JICA Project Team

Figure E.17: Sidewalk Width

(3) Standard Cross-Section Width

Cross-section width should be decided in consideration of road function and roadside land use based on a geometric road design standards, with reference to Figures E.18 and E.19 (the latter for BRT).



Source: JICA Project Team

Figure E.18: Standard Cross Section

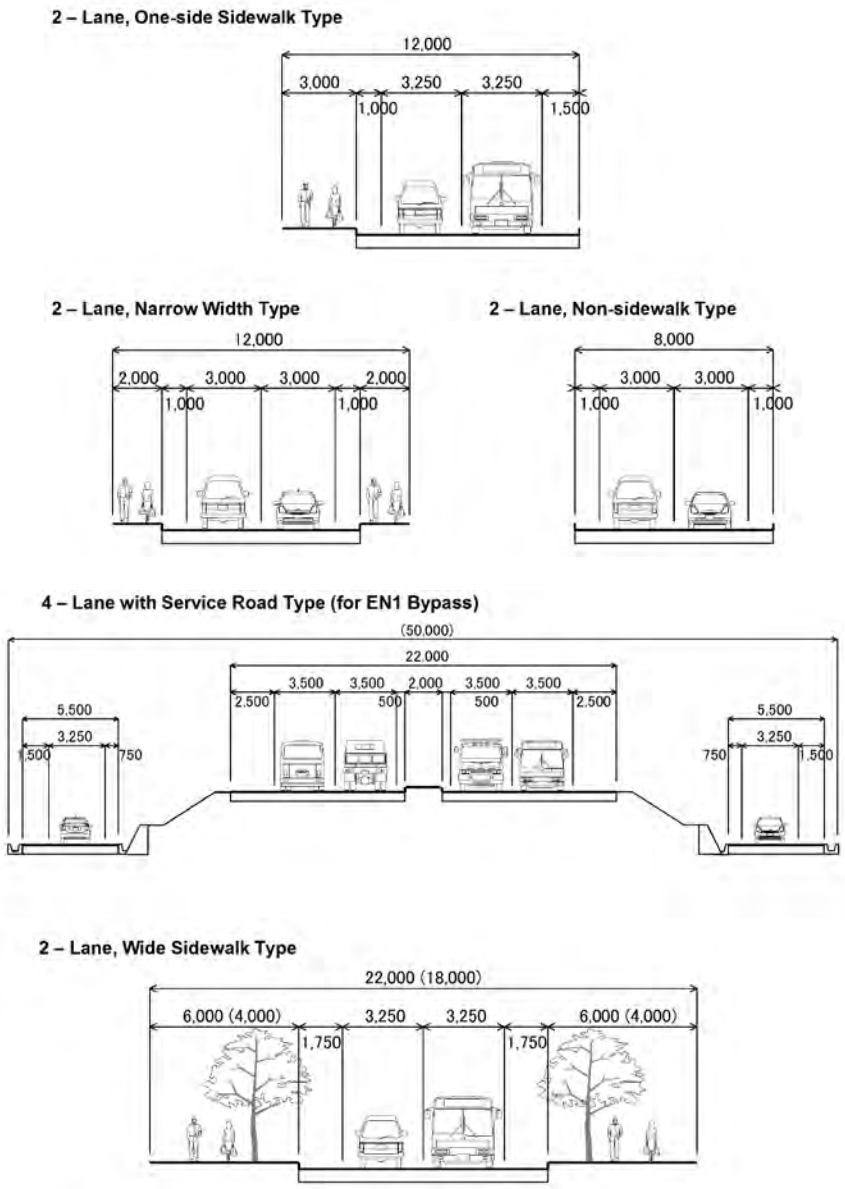
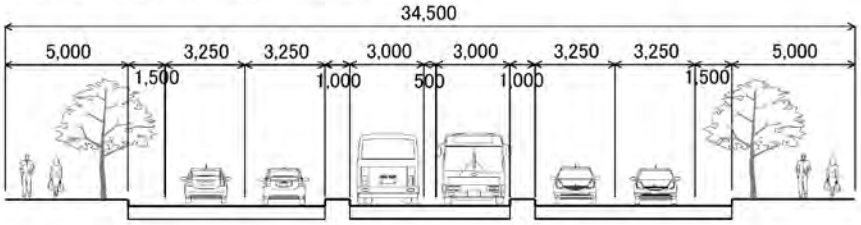


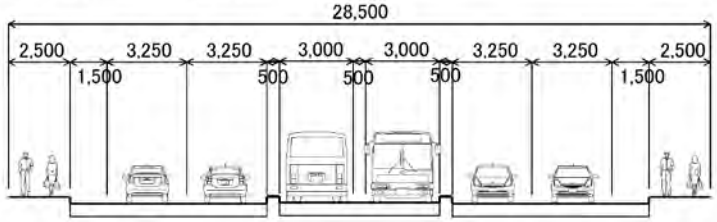
Figure E.18: Standard Cross Section (continued)

BRT Standard Cross Section

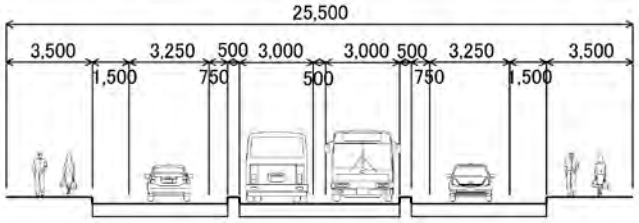
BRT with 4–lane Standard Type (Desirable)



BRT with 4–lane Reduction Type (Minimum)

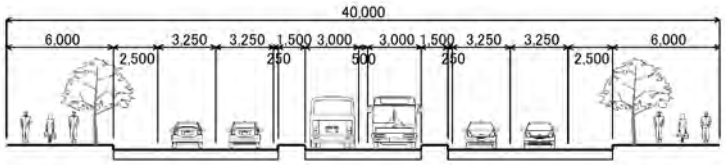


BRT with 2–lane Standard Type

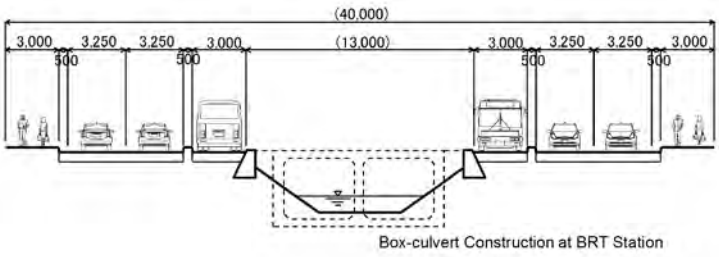


BRT Special Cross Section

BRT Maputo Central Urban Line (Av. Eduardo Mondlane) BRT + 4-lane



BRT Maputo Machava East-west Line (Av. Joaquim Chissano) BRT + 4-lane



Source: JICA Project Team

Figure E.19: Standard BRT Cross Section

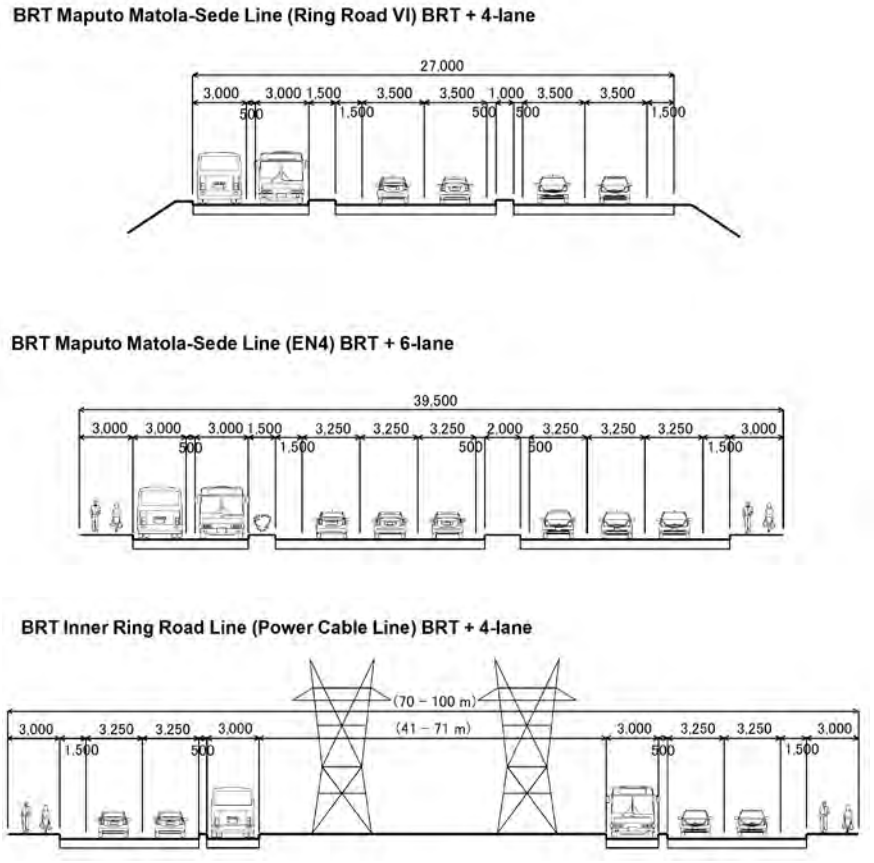


Figure E.19: Standard BRT Cross Section (continued)

E.4.3 Design Standards

(1) Introduction

The design standards for roads used in Maputo municipality and its neighboring districts are based on the draft design standards of ANE. Items not included in the ANE standards are based on the Standard Specifications for Road and Bridge Works of the Southern Africa Transport and Communications Commission (SATCC). The loading conditions of bridges are to be verified according to the provisions of the Safety Regulation and Actions for Buildings and Bridge Structures (Regulamento de Segurança e Acções para Estruturas de Edificios e Ponte, RSAEP) of Portugal. Table E.22 lists the design standards to be used and their corresponding publication dates.

Table E.22: Road Design Standards

Agency	Standards	Publication Date
SATCC	Standard Specifications for Road and Bridge Works	September1998
ANE	ANE Design Standards (Draft)	March 2001

(2) Road Classifications of Each Organization

ANE classifies most roads in Mozambique as primary, secondary, tertiary, and local roads, each having a specific road standard, geometric design, width formation, and the like (some roads remain unclassified by ANE). The Maputo municipality has a classification similar to that of

ANE. The Matola municipality and outlying districts (Marracuene and Boane) have no such classifications. Table E.23 lists the road classification schemes of each organization.

Table E.23: Road Classification Schemes of Each Organization

Organization	Classified		Remarks
ANE	Classified Road	Primary Secondary Tertiary Local	---
	Not Classified		
Maputo	Primary Secondary Tertiary Impassable and other		Differs from ANE's classified road.
Matola Marracuene Boane	Not Classified		---

Source: JICA Project Team

(3) ANE Geometric Design Standards

Table E.24 sets out ANE's geometric design standards.

Table E.24: ANE Geometric Design Standards

1. Design Speed

a) Desirable

TABLE 1A: DESIRABLE MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR SURFACED ROADS

No	DESCRIPTION	ROAD CLASS		
		Primary	Secondary	Tertiary
1	GENERAL			
	1.1 Minimum Design Speed	100 km/h	80 km/h	60 km/h
	1.2 Minimum Spacing between Intersections	600 m	300 m	200 m

b) Minimum

TABLE 1B: MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR SURFACED ROADS

No	DESCRIPTION	ROAD CLASS		
		Primary	Secondary	Tertiary
1	GENERAL			
	1.1 Minimum Design Speed	60 km/h	60 km/h	40 km/h
	1.2 Minimum Spacing between Intersections	400 m	200 m	200 m

2. Width

a) Desirable

TABLE 1A: DESIRABLE MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR SURFACED ROADS

No	DESCRIPTION	ROAD CLASS		
		Primary	Secondary	Tertiary
4	LANE WIDTH			
	4.1 Minimum lane width	3,5 m	3,0 m	3,0 m
	4.2 Minimum surfaced shoulder width	1,5 m	1,0 m	0,5 m
	4.3 Minimum unpaved shoulder width			
	- with a paved shoulder	1,0 m	0,5 m	0,5 m
	- without a paved shoulder	3,0 m	1,5 m	1,0 m

b) Minimum

TABLE 1B: MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR SURFACED ROADS

No	DESCRIPTION	ROAD CLASS		
		Primary	Secondary	Tertiary
4	LANE WIDTH			
	4.1 Minimum lane width	3,1 m	3,0 m	3,0 m
	4.2 Minimum surfaced shoulder width	0 m	0 m	0 m
	4.3 Minimum unpaved shoulder width			
	- with a paved shoulder	0,5 m	0 m	0 m
	- without a paved shoulder	1,5m	0,5 m	0,5 m

c) Unpaved Road Desirable

TABLE 4A: DESIRABLE MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR UNPAVED ROADS

No	DESCRIPTION	ROAD CATEGORY		
		Primary	Secondary	Tertiary
4	ROAD WIDTH[1]			
	4.1 Minimum pavement width	N/A	6,0 m	6,0 m
	4.2 Minimum formation width	N/A	10,0 m	7,0 m

d) Unpaved Road Minimum

TABLE 4B: ABSOLUTE MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR UNPAVED ROADS

No	DESCRIPTION	ROAD CLASSES		
		Primary	Secondary	Terciary
4	ROAD WIDTH			
	4.1 Minimum pavement width	5,5 m	5,0m	4,0 m
	4.2 Minimum formation width	12,0 m	10,0 m	4,5 m

3. Alignment

a) Desirable

TABLE 1A: DESIRABLE MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR SURFACED ROADS

No	DESCRIPTION	ROAD CLASS		
		Primary	Secondary	Tertiary
2	HORIZONTAL ALIGNMENT			
	2.1 Minimum radius	350 m	210 m	110 m
	2.2 Minimum crossfall of surfaced road			
	- For vertical grade > 0,5%	2%	2%	2%
	- For vertical grade <=0,5%	3%	3%	3%
	2.3 Minimum crossfall of unpaved gravel shoulders	4,0%	4,0%	4,0%
	2.4 Minimum crossfall of unpaved sand shoulders	2%	2%	2%
	2.5 Maximum Superelevation	8%	8%	8%
	VERTICAL ALIGNMENT			
	3.1 Maximum longitudinal grade	5%	6%	7%
	3.2 Minimum longitudinal grade	0,2%	0,2%	0,2%

b) Minimum

TABLE 1B: MINIMUM GEOMETRIC DESIGN REQUIREMENTS FOR SURFACED ROADS

No	DESCRIPTION	ROAD CLASS		
		Primary	Secondary	Tertiary
2	HORIZONTAL ALIGNMENT			
	2.1 Minimum radius	115 m	115 m	50 m
	2.2 Desirable minimum radius	250 m	200 m	150 m
	2.3 Minimum Crossfall of surfaced cross section			
	- For vertical grade > 0,5%	2%	2%	2%
	- For vertical grade <=0,5%	3%	3%	3%
	2.4 Minimum Crossfall of unpaved gravel shoulders	4,0%	4,0%	4,0%
	2.5 Minimum Crossfall of unpaved sandy shoulders	2,0%	2,0%	2,0%
	2.6 Maximum Superelevation	10%	10%	10%
	2.7 Minimum Superelevation	3%	3%	3%
	VERTICAL ALIGNMENT			
	3.1 Maximum longitudinal grade	6%	7%	8%
	3.2 Minimum longitudinal grade	0%	0%	0%

Source: ANE's Design Standards (Draft)

E.5 Pavement Maintenance Cost

Generally, pavement design conditions should be established considering a service life of 15–20 years and reliability of 80%, i.e., about 20% of the pavement will break after 15–20 years. That broken pavement should be repaired regularly. Table E.25 estimates the annual cost of pavement maintenance on this basis.

Table E.25: Annual Cost for Pavement Maintenance

Durable years:	15	year
Design Reliability:	80%	%
Carriageway Width:	8	m
Repair Ratio:	80%	%

	Year	Paved Length km	Damage Length km	Annual Damage m2	Annual Repair Area m2	Unit USD/m2	Annual Repair Cost USD
Maputo	2013	359	72	38,300	30,600	50	1,530,000
	2035	537	107	57,300	45,800	50	2,290,000
Matola	2013	182	36	19,400	15,500	50	775,000
	2035	351	70	37,500	30,000	50	1,500,000
Marracuene	2013	35	7	3,800	3,000	50	150,000
	2035	97	19	10,300	8,200	50	410,000
Boane	2013	31	6	3,300	2,600	50	130,000
	2035	84	17	8,900	7,100	50	355,000
Total	2013	608	122	64,800	51,700		2,585,000
	2035	1,069	214	114,000	91,100		4,555,000

Source: JICA Project Team

E.6 Greenbelt River Runoff and Drainage Capacity

The runoff and drainage capacity in a greenbelt river was analyzed. The runoff was calculated by the so-called Rational Method and the drainage capacity was calculated by the Manning Method. Rainfall intensity and the runoff coefficient was based on topography and land use. Key findings follow:

- Existing river cross sections have insufficient drainage capacity for many levels of rainfall.
- There is the possibility of traffic stopping along the EN4 and the railway.
- Improvement to a large size cross section and construction of a bridge for road and railway traffic is required.
- The greenbelt should be utilized as a flood control basin.
- For the specification of a river cross section, the correlation between rainfall and runoff should be surveyed for the river basin.

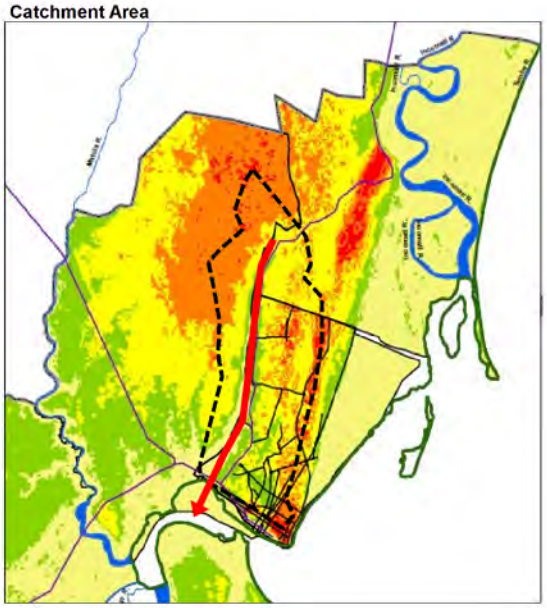
Figure E.20 provides more details on the analysis using the Rational Method.

Green-belt River Runoff and Drainage Capacity

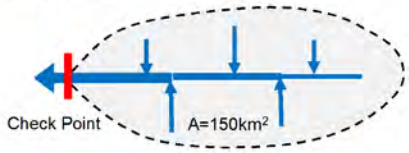
Runoff Coefficient: C= 0.45
Rainfall Intensity: I= 10 mm/h
Rational Method
Q = 1/3.6 * C * I * A

Runoff Volume				Drainage Capacity								
No	Catchment Area A' (km²)	Amount A (km²)	Runoff Qo (m3/s)	Cross Section	Section Area A(m²)	Wetted Perimeter S(m)	Hydraulic Mean R(m)	Roughness coefficient n	Incline i(%)	Flow Velocity V(m/s)	Capacity Qa(m3/s)	Safety Factor
1	150	150	187.500	Existing W10 * H2.0	20.0	14.0	1.429	0.025	0.10%	1.604	32.089	0.17 OUT
				Proposal W28 * H3.0	84.0	34.0	2.471	0.025	0.10%	2.312	194.181	1.04 OK

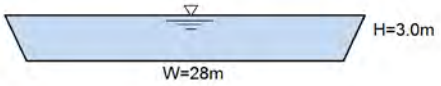
Catchment Area



Runoff Model



Necessary River Cross Section



Source: JICA Project Team

Figure E.20: Greenbelt River Runoff and Drainage Capacity

Technical Report F

Public Transport Improvement

Contents

Figures

Table

Technical Report F Public Transport Improvement

F.1 Introduction

F.1.1 Overview

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

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

Following this introduction, this technical report sets out a review of the following:

- Public transport modes;
- Public transport route network;
- Route network concept proposals;
- Public transport infrastructure;
- Public transport fare levels and structure;
- Public transport industry structure; and
- Capacity development requirements.

Each of these issues is discussed in detail, with a description of the existing situation, followed by a discussion of the issues and options, and identification of the recommended actions.

F.1.2 Vision and Objectives

Although improvements have been made in recent years, in most respects the existing public transport services are inefficient, inadequate and unreliable, and offer poor value for money. Many of the vehicles used are unsuitable for the purpose, are in poor condition and badly driven. The private sector, which has by far the greatest market share, is fragmented and disorganised and can only function by disregarding regulations. The services provided by the public sector bus operator are infrequent and unreliable, and inadequate to meet demand; they incur substantial losses which are made good by government.

Public transport in Greater Maputo should comprise a well planned route network making optimal use of all available modes, with service levels adequate to meet demand on all routes. Appropriately specified vehicles, maintained to a high standard of safety and reliability, should be used for all services. Operation should be efficient and well organised, and should be profitable at affordable fares.

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

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

- Socially sustainable urban transport;
- Environmentally sustainable urban transport; and
- Urban transport facilitating the international gateway.

The vision identified that increasing mobility and accessibility by improving public transport was central to this.

This vision is achievable but the implementation task will not be an easy one. It will require motivation and determination throughout the public and private sectors to make it work. The Transport Master Plan provides a road map towards that end.

F.1.3 Principal Public Transport Policies and Strategy

To achieve the vision, the Greater Maputo Urban Transport Master Plan sets out the following overarching public transport policies.

(1) Introduce Mass Transit Systems (e.g., Commuter Rail, LRT, BRT)

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

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

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

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

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

(4) Improve Public Transport Infrastructure

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

(5) Ensure Use of Appropriately Specified Vehicles

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

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

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

(7) Implement a Financially Sustainable Fare Structure

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

(8) Improve Institutional Capacity

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

F.2 Public Transport Modes

F.2.1 Existing Situation

The public transport system in Greater Maputo at present is primarily road-based. There is an extensive network of routes operated by informal minibuses, known as *"chapas",* with some full-sized buses, mostly owned by public sector companies, operating on certain routes. These road services are complemented by ferry services between Maputo and Catembe, and across the Incomati River ferry at Marracuene, and a limited commuter rail service using part of the national rail system.

(1) Chapas

Public passenger transport services in Greater Maputo are provided principally by small private sector operators using vehicles known as "*chapas*", mostly 15-seat minibuses or medium-sized vehicles seating about 25. There are estimated to be between 4,000 and 4,500, *chapas,* operating on approximately 130 routes. Household interview surveys carried out during the study show that approximately 60% of all non-walking/bicycle trips were made by *chapa*, and only 17% by conventional bus.

Key points regarding the existing provision and operations of *Chapas* in Greater Maputo include the following:

- C*hapas* are owned by private individuals, many of whom own only one vehicle. They are rented out to drivers for a daily charge. The driver pays for the direct running costs, including fuel, tyres, minor maintenance and the salary of the conductor, out of the fares collected; the rest is retained as his income.
- C*hapas* are operated on an informal basis on the traditional "fill and go" system, normally waiting at terminals until a full load of passengers has accumulated before departing. This restricts capacity for passenger wishing to board en route. Services are regulated by the operators' associations, which appoint officials to control the departure of vehicles from the terminals.
- Most *chapas* are old and poorly maintained, and are in poor condition: many are unsafe. The operators attribute the poor maintenance standards to their financial situation: they

claim that fare levels approved by government are inadequate to cover all costs. The *chapa* drivers are responsible for most maintenance. Their contractual arrangement with the vehicle owners, which requires them to bear the cost of all routine maintenance and minor repairs, encourages them to minimise expenditure, and they tend to have the minimum maintenance work done which is necessary to keep their vehicles in operation.

- As a result, many *chapas* may be seen emitting excessive black smoke (which not only creates pollution but indicates excessive fuel and oil consumption), with worn tyres, defective lights, cracked windscreens, broken windows, damaged or missing rear-view mirrors and other defects, and it is likely that other safety-related items such as brakes and steering are also poorly maintained.
- Ineffective safety inspection procedures compound the problem, although more effective enforcement measures implemented recently by INATTER have resulted in the *chapas* the worst condition being taken out of service in Greater Maputo; however, many are reported to have been redeployed to more remote areas where the enforcement of regulations is less strict.
- According to FEMATRO, about 4,500 chapas were licensed and operating in Greater Maputo in 2004. There has been a decline in numbers since, partly due to increasing costs without commensurate increases in fare levels but also because the Maputo municipality stopped issuing licences for minibuses with fewer than 25 seats in 2009. Due to ineffective enforcement many of the 15-seaters continued to operate illegally, without licences; the ruling was reversed in July 2012, and the municipality recommenced licensing the smaller chapas.
- In addition, there are many small and medium-sized open trucks without seats operating illegally as *chapas*, mainly at peak periods but some throughout the day; it is difficult to determine how many.

The *chapas* provide an essential service for most people, but the type of vehicle currently used for the majority of services is inefficient and unsuitable for urban services carrying large volumes of traffic. Full-size buses would be more efficient and more suitable in a modern urban environment. This is reflected in current government policy, which discourages the use of small public transport vehicles in city centres, but which in practice is currently not being implemented.

Operational and performance data in respect of *chapa* services from surveys undertaken at a sample of terminals are given in Section K7 in Technical Report K: Transport and Traffic Surveys: Methodology and Analysis.

(2) Buses

There are approximately 200 full-sized buses operating in Maputo. The majority are operated by the publicly owned TPM (Transportes Publicos de Maputo) on approximately 60 routes, while approximately 60 are owned by private individuals, and are operated on a similarly informal basis as the *chapas.*

Key points regarding the existing provision and operations of buses in Greater Maputo include the following:

- TPM is in the process of being reorganised and divided into new companies under the control of Maputo and Matola municipalities, together with some smaller companies operating in provincial towns. Although the legal change has been made, there has been no physical change to the operation in Maputo, which continues to be managed from the headquarters of the Maputo company.

- As of 2013, TPM owns approximately 340 buses, of a variety of makes and models, mostly less than six years old. Many of the older vehicles are unserviceable due to a backlog of maintenance and shortage of spare parts, and TPM typically operates only approximately 140 buses daily on services in Greater Maputo.
- However, TPM's situation has improved in recent years. The bus fleet has been increased substantially: in mid-2008 approximately 40 buses were operated daily on 24 routes, compared to 140 on 60 routes in 2013; however, the number of buses operated is still a relatively small percentage of the total fleet, with many buses out of service awaiting parts.
- Some full-sized buses are operated in Maputo by private sector operators. A very small number of city buses, imported second-hand, have been operated by individual owners for several years. In July 2011 50 new buses were imported from India and were allocated to private sector operators.

(3) Taxis and Txopelas

The bus and *chapa* services are complemented by approximately 1,000 saloon car taxis, 300 15-seat taxis operating as school buses, and 200 *txopelas* (three-wheel scooter-based open taxis manufactured by Bajaj in India). The taxis and *txopelas* carry individuals or small groups on a point-to-point basis and do not operate on a shared basis on fixed routes as in many other African countries.

According to the taxi operators' association, the number of taxis is increasing rapidly; there were only 150 three years ago. Taxis are rated according to their quality. Only A-rated taxis may use the stands at the Airport and 4/5-star hotels; B-rated taxis may use other stands in the city, and C-rated taxis are restricted to stands outside the city centre, such as Benfica and Junta.

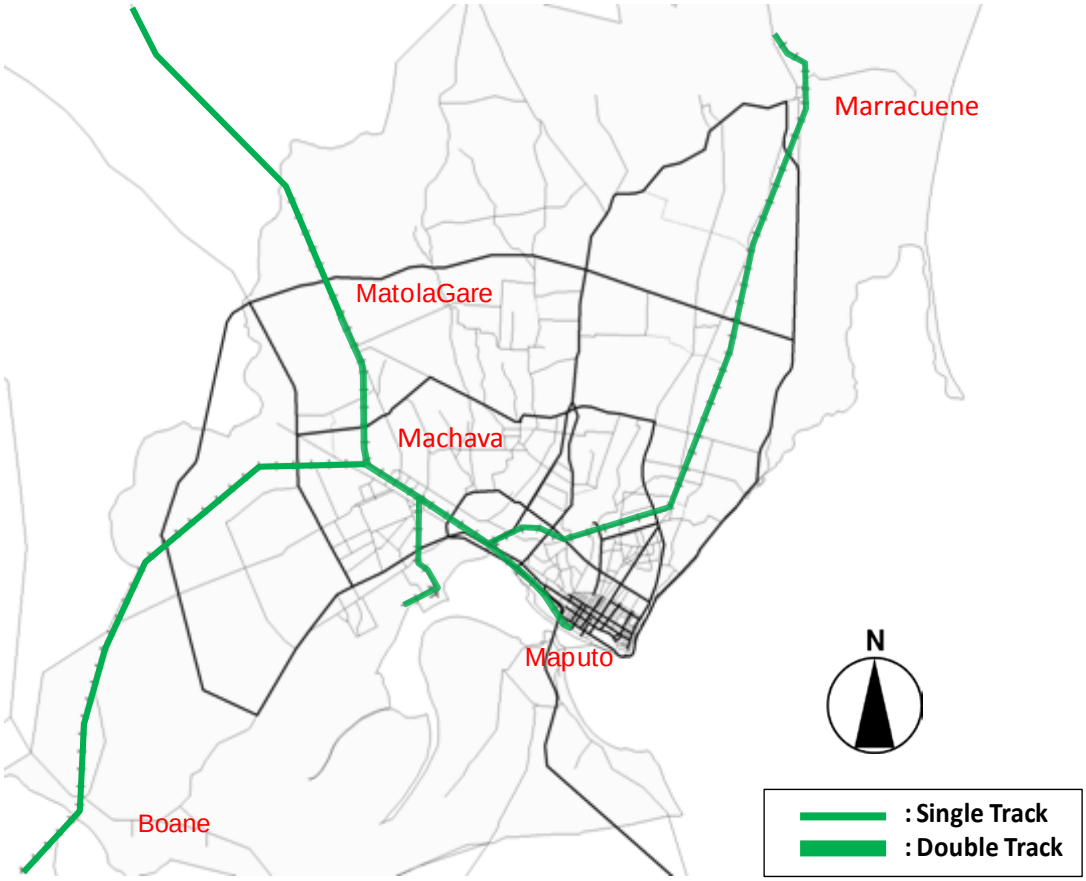
Txopelas (three-wheel scooter-based open taxis manufactured in India) were introduced in Maputo around 2010. There is no *txopela* operators' association, but FEMATRO estimates that there are about 200 *txopelas* operating in Maputo and Matola, mostly owned by small businesses which rent them out to the drivers. They charge lower fares than taxis (typically MT 35 per km), and there are no set fares. They congregate at busy places such as markets looking for passengers.

(4) Long-Distance Buses

The majority of vehicles used on inter-city bus services from Maputo to towns and cities throughout Mozambique are 15-25 seaters similar to the *chapas* operating in the city, but a small number of full-sized buses are also used on some routes. The majority of international services to neighbouring countries such as South Africa and Swaziland are operated by minibuses with up to 15 seats, mostly with trailers to carry passengers' luggage and freight. Some full-sized buses are also operated; these use only the Junta terminal. In addition, there are luxury international services using full-sized buses operated by specialist companies, mostly based in South Africa.

(5) Rail Transport

The railway and ports company, CFM, operates three rail routes from Maputo, to Swaziland, via Boane; to South Africa, via Matola; and to Malawi, via Manhica. Its primary business is freight transport. Passenger trains stop at all intermediate stations, and carry intermediate local traffic within Mozambique. The section of line between Maputo and Matola Gare is double-tracked; all other lines are single track. Existing rail routes in Greater Maputo are shown in Figure F.1



Source: JICA Project Team

Figure F.1: Existing Railway Routes in Greater Maputo

CFM operates two categories of passenger train: "regular", or long-distance services, with first, second and third class accommodation, and "urban" services, with only third class accommodation (although this is similar to second class on regular trains) for shorter distance commuter traffic. Most regular trains operate only once daily in each direction; some run only on certain days.

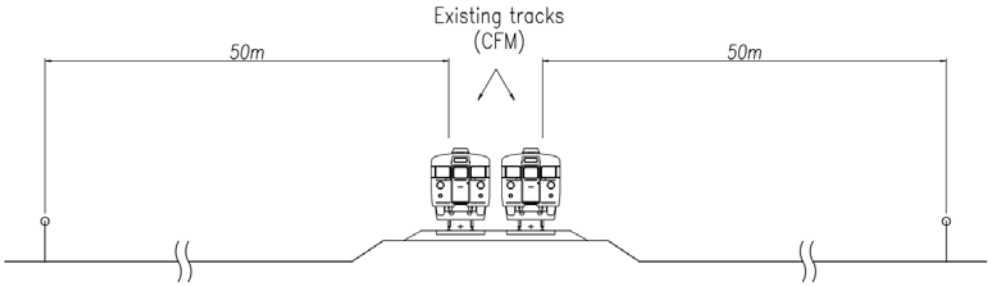
Urban services are operated to Manhica (79 kilometres) via Marracuene (2 trains daily in each direction); Ressano Garcia (88 kilometres) via Machava and Matola (2 trains daily in each direction); Goba (69 kilometres) via Machava and Boane (2 trains daily in each direction); and Matola Gare (20 kilometres) via Machava (4 trains daily in each direction).

Three 3-car diesel-electric multiple units (demus) are normally used to operate these services (one on each of the three lines), but availability has been affected by damage by vandals and the full scheduled service is not always operated.

Although there has been a substantial increase in the number of passengers carried on urban trains since 2007, the CFM rail system currently accounts for a small fraction of the total trips made in Greater Maputo.

CFM holds the right-of-way along the rail track for 50 m on both sides of the outermost rails (see Figure F.2). However, there are many illegal dwellings within the right-of-way. CFM's main operation is for freight transport. Goods unloaded at Maputo Port adjacent to Maputo Station are transported by railways to various parts of the country and beyond and goods

originating in Mozambique and neighbouring countries are also transported by railways to Maputo Port.



Source: JICA Project Team

Figure F.2: Existing Rail Right of Way

All tracks are of ballast type, constituted by ballast, sleeper, and rail. The JICA Project Team's railway expert's field observation found the tracks well maintained. Fresh ballast seemed to be regularly supplied and cant has been maintained. Sleepers are mainly of precast concrete. Some wooden sleepers exist. Few are severely damaged and intervals are well maintained.

Rails are made into long rail by welding. Currently 35 kg/m rails are used. According to a CFM official existing rails are gradually replaced with heavier rails. All switching points are operated manually. No train communication line is used. There used to be automatic switching points and train communication lines. They are no longer used. Communication between trains and stations is done by wireless. Block closing is managed by exchange of pass at stations.

At a few road crossing locations grade separation is done. Great majority of road crossing is by at-grade crossing. No closing bars and other safety devices exist at the moment. At each of road crossings some attendants are placed and they stop traffic by warning horns whenever a train approaches.

(6) Ferries

Transmaritima currently operates two services in Greater Maputo, a ferry for vehicles and foot passengers from Maputo to Catembe, and a service from Maputo to Inhaca for foot passengers only. Both use the same terminal in Baixa. Until October 2010 there was also a service from Maputo to Matola Rio, but this was withdrawn because it was not viable. The Incomati River ferry at Marracuene is operated by Marracuene Municipality. There are no other ferry services in Greater Maputo.

There are also some privately operated vessels. There is a service from Maputo to Machangulu (five miles south of Inhaca) and an operator with three boats (capacity 30 passengers each) operating between Maputo and Catembe (using the same terminals as Transmaritima). They operate like the *chapas*, and depart only when full.

Approximately 4,500 passengers and 150 vehicles are carried daily on the Catembe service (22 crossings in each direction), and 75 passengers on each day the Inhaca service which operates four days per week, one return journey.

It is not thought that the opening of the Catembe Bridge will affect the ferry traffic since the location of the bridge access points will be inconvenient. Moreover, it has been pointed out that the capacity of bridge will be inadequate for the planned development, and therefore there will be a continuing requirement for the ferries as a complementary service.

F.2.2 Issues

One of the overarching key issues regarding transport modes in Greater Maputo is that for maximum efficiency, it is essential that Greater Maputo's public transport system comprises the appropriate combination of modes, with each performing the tasks which it does best. The present situation is far from satisfactory. The predominance of the informal sector precludes the provision of a well planned and organised service which is tailored to passengers' actual requirements; while the widespread use of small and medium-sized *chapas* makes inefficient use of road space, increases the level of exhaust emissions, and makes services difficult to regulate. The situation is worsened by the generally poor condition of the vehicles.

Already, the public transport system in Greater Maputo is unable to cater adequately for passengers' (and potential passengers') requirements. The population is increasing steadily, and so too is the demand for transport. Therefore an important longer-term issue is therefore the need to determine the appropriate mix of public transport modes to meet the future passenger transport requirements in Greater Maputo. Selection of modes must take into account the appropriateness and relevance of each in the context of the local environment, and the constraints of capacity, capability, funding and culture which determine what will work and what will not.

For road-based public transport modes, an important, and often sensitive, issue is the question of allocation of road space. On many of the streets in Maputo, there is insufficient space for existing volumes of private and public transport vehicles, both moving and parked. Public transport carries the majority of people, and it may be argued that buses (and other public transport vehicles) should be given priority, with restrictions on the use of road space by private transport vehicles.

Most roads along the main corridors are wide enough to accommodate exclusive bus lanes as well as other traffic, although it will be necessary to prohibit parking at the side and/or in the centre of some roads. However, some of the streets in central Maputo, where large numbers of people are travelling to and from and which should therefore be served by the primary bus services, are narrower and already heavily congested.

This raises a common problem: where bus priority measures are needed most, the demands of other traffic are equally pressing, and the choice must be made as to whether to give buses priority over other traffic (possibly to the extent of designating some city-centre streets as bus-only streets), which would benefit the majority of road users but increase delays for car users, or to force buses to mix with other traffic, and continue to suffer delays in consequence. An alternative approach which is sometimes adopted is to route buses along roads where there is sufficient capacity, but which do not take the passengers close to their destinations. To a large extent this is a political choice: the majority of voters may be public transport users, but private car owners often have greater influence.

F.2.3 Options

There are several transport modes which may be appropriate to the future urban transport requirements of Greater Maputo, and the potential for each has been examined in order to determine a preferred combination of modes to best meet the overall requirement in the long term. This section sets out a review of each potential option for consideration including:

- Heavy rail
- Light rail
- BRT

- Conventional buses
- Informal public transport modes
- Water transport

In order to provide maximum accessibility, there must continue to be substantial dependence on road-based public transport modes, which can provide the maximum level of accessibility; there are various options to be considered in terms of the services provided and types of vehicles operated and these are discussed later in this section.

The optimal system will comprise a combination of some or all of the above modes. The preferred scenario is set out later in this document.

(1) Heavy Rail

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

In Greater Maputo, it is unlikely that the construction of new urban rail lines will be justifiable, however, developing the passenger services on existing rail lines is recommended in the long term.

Due to a rail system's ability to attract a large number of trip makers along a fixed corridor, land use along the corridor often becomes denser (particularly at nodes). Land use becomes more concentrated along the corridor. This Transit Oriented Development (TOD) is in line with the public transport policies already outlined and therefore is a key component in making rail a successful component of the integrated public transport system.

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

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

(2) Light Rail

Light rail transit (LRT) systems, including monorail and other less conventional systems, are generally constructed solely for the operation of passenger trains providing relatively high frequency urban and suburban services. They have many of the characteristics of heavy rail systems but are constructed to cater for vehicles of lower weight and usually to smaller dimensions. As a result they can be significantly cheaper in terms of both capital and operating costs, although capacity is also lower.

Street tramway systems are LRT systems which operate on city streets alongside other traffic, and as such have much in common with conventional bus services: they do not require special infrastructure at stopping places, which may be spaced as closely as every 300 metres, or even less. A disadvantage shared with buses is that they can be obstructed by other road traffic: in fact, if the track is obstructed, for example by an accident, the bus has the advantage over the tram of being more able to avoid the obstruction.

Some tramway systems operate entirely on streets; however, many incorporate lengths of dedicated track, which may be at, above or below street level, on which the trams are fully segregated from other traffic. Away from city centres, it is often practical to provide dedicated track alongside or away from the main highway; sometimes the central median strip of a dual carriageway is used for this purpose.

LRT and street tramway systems are efficient movers of large volumes of passenger traffic. On most systems the vehicles may operate as single units or as short trains of two or three vehicles. This makes efficient use of road space, and the facility to add extra vehicles makes it relatively easy to increase capacity at peak periods without requiring additional staff. Crew productivity is substantially higher than for buses, although this is less of an issue in developing countries where wage costs are generally low, than in developed countries where labour costs are usually significant.

The capital cost of a tram or LRT vehicle is typically three times that of a large conventional double deck bus, but it will have a life approximately twice as long, while its carrying capacity may be up to 50% more. Direct operating costs for LRT and street trams are lower than those for buses, but the fixed costs of infrastructure and rolling stock are much higher; therefore the overall cost per passenger by rail is lower than by bus only where there are high volumes of traffic.

Urban rail systems involve considerable capital expenditure and incur high operating costs. There are very few systems in the world which are able to cover all their costs from revenue (those which do, such as that in Hong Kong, derive a substantial proportion of their income from sources such as income from property developments along the line of the route, and not from fares).

In practice, experience in many large cities around the world has shown that BRT systems have many of the advantages of LRT, but at much lower cost, and with a far greater degree of operational flexibility. A closed BRT system is normally adequate for all but the busiest corridors; this has been demonstrated in cities in Latin America. Moreover, BRT provides the option for future conversion to LRT along the same alignment if traffic volumes and potential revenue increase to a level which justifies the investment and operating costs. A pragmatic approach may well be to plan for a BRT system which may (or may not, as the case may be) be upgraded to LRT at some unspecified future date.

(3) BRT

On the main route corridors, where passenger volumes are very high, it will be necessary to give buses priority over other traffic in order to provide adequate capacity. Bus Rapid Transit (BRT) is a term generally used to refer to a high-capacity bus system in which buses operate on tracks which are segregated from other traffic for all or part of the route. There are many variations on the BRT theme in terms of the types of vehicles used, infrastructure and operating systems, and there is thus a wide range of options. The most appropriate combination of options for any particular situation depends on a range of factors, including:

- Volume of passenger traffic
- Passengers' travel patterns
- Volume of other road traffic
- Availability of road space
- Road network characteristics
- Bus route network characteristics
- Road conditions
- Land use pattern
- Enforceability of regulations
- Transport industry structure
- Technical capability
- Operational capability
- Passenger preferences (e.g. acceptance of need for interchange)
- Operator discipline
- Passenger discipline
- Funding capability (e.g. passengers' ability to pay, availability of funds for subsidy)

There are broadly two options for a BRT system:

- **"Closed" system**: using vehicles designed specifically for use on the busway and which cannot be used on ordinary roads unless there is special provision for the BRT buses at stopping places; buses designed for use on normal roads cannot operate on the busway.
- **"Open" system**: which may be used by buses designed for use on ordinary roads. With an open system, bus routes originating at outlying points may follow ordinary roads for part of the route, and converge on the busway for the "trunk" part of the route; they may diverge on entering the city centre area to provide good coverage of the central area and giving flexibility.

However most modern BRT Systems are described as "closed" systems – as the passengers, once within the system area/units, can go anywhere within the network. This term unfortunately conveys a negative impression and with smart-card technology is now no longer true. The Brazilian term "*Integrated",* is more appropriate as all sections – or even modes – operate as a single system.

A more detailed summary of the principal options for BRT are itemised in the following table.

Table F.1: BRT Options

Characteristic	Options	Description	Advantages	Disadvantages	Remarks
Segregation	Physical segregation (Busway)	Busway physically separated from road space used by other traffic	Easy to enforce. Higher operating speeds possible. Safer.	Impedes pedestrian movement. Requires more space than bus lane. May be blocked by broken-down buses.	
	Bus lane	Bus-only lane demarcated by painted lines on road surface	Inexpensive. Buses may leave bus lane to pass obstructions such as broken-down buses. Flexible (easily changed).	Difficult to enforce, particularly where compliance with regulations is poor generally.	
Open/closed	Open	Buses are not restricted to the busway, but may enter or leave at intermediate points.	Increases route options. May be used by any type of bus if required. Need not be continuous. May be implemented progressively. Reduces need for feeders and interchanges.	Complexity of operation/control. Reduces capacity of busway.	More flexible than closed system.
	Closed	Buses operate only on the busway.	Ease of control. Buses may be designed specifically for BRT use.	Passengers to/from points not on the busway must use feeder services and interchange – increases infrastructure requirement.	Suitable for carrying high volumes.
Busway Location	Centre of Road	Busway in median strip of dual carriageway	Minimal conflict with other traffic.	Unless strip is very wide (10m or more) bus stops require "bulges" in median	Almost universal for closed BRT systems.
	One Side of Road	Busway tracks for both directions adjacent to one kerb		Problems of traffic turning across busway	Unlikely to be practical
	Both sides of Road	Busway track for each direction adjacent to appropriate kerbside	Reduced conflict with other traffic if busway is not continuous	Problems of traffic turning across busway	
	Away from road alignment		Minimal conflict with other road traffic.	Potential accessibility problems	
Basic bus configuration (N.B. it is normally desirable to use only one standard vehicle type on a busway, particularly if frequencies are very high). Buses must be reliable to minimise breakdowns on busways.	Single deck rigid	Up to 15m long	Lower capital cost.		
	Single deck articulated	Up to 27m long (possibly more)	Very high capacity (up to 275+ if majority standing).	Mechanically complex. Higher cost.	Typically used on closed BRT systems.
	Double deck (rigid)	Up to 15m long but more typically 12m max. Up to 4.5m high.	Can carry high proportion seated passengers. More efficient use of road space – more relevant in congested city streets.	Higher cost. Cannot be used if insufficient overhead clearance throughout route.	

Characteristic	Options	Description	Advantages	Disadvantages	Remarks
Bus floor height	High Floor	Floor height is above top of wheels (approx 1m or more)	Flat floor possible throughout vehicle. Increases bus capacity, and more seats can be accommodated than with low floor.	High loading platforms required (or several entrance/exit steps inside vehicle making access inconvenient). If steps inside bus, difficult access to bus, and slow loading/unloading.	At-floor-level boarding desirable for BRT regardless of floor height. If high loading platforms required, buses cannot pick up/set down passengers except on busway (or if platforms are constructed on sidewalks, causing obstruction).
	Low Floor	Minimal floor height, particularly adjacent to entrances/exits (30 cm or less)	Ease of access from kerb level. Relatively low boarding platforms required to provide at-floor-level boarding.	Intrusion of wheel arches, engine etc limits floor capacity and number of seats. More complex mechanically.	Low floor buses also require smooth roads.
Seating options	Most passengers seated		Maximises comfort.	Reduces service capacity. Slower loading/unloading	Particularly relevant for long journeys
	Most passengers standing		Maximises service capacity. Faster loading/unloading	Reduced comfort. Safety issues.	More suitable for short journeys, and on routes with high passenger turnover.
Door position	Nearside (normal)	Passenger entrance/exit doors on kerb side	Buses may operate on or off busway.	Requires additional space for bus stops if busway is in centre of road	Normal for open BRT systems.
	Offside	Passenger entrance/exit doors on opposite side to kerb: necessary if centre-island loading platforms at stops.	Permits centre island loading, minimising space required for bus stops, and construction costs for stops, if busway is in centre of road	Buses restricted to busway	Common for closed BRT systems.
	Both sides		Buses may operate on or off busway.	Reduced bus capacity.	Common in China.
Control	Not guided	Bus steered by driver in normal way.			
	Guided (various systems)	Buses fitted with equipment which steers the bus automatically; driver still controls bus speed. May be used	Reduced busway width requirement – may save 0.5m per track.	Only buses fitted with guide equipment may be used on busway. Increased mechanical complexity (but not substantially).	Relatively common in Europe (mainly UK) but less so elsewhere. Only relevant where road width is severely

Characteristic	Options	Description	Advantages	Disadvantages	Remarks
		throughout busway or on some sections only – bus can be driven normally where required. Sometimes used only at stops to ensure accurate alignment with boarding platform			limited.
Number of bus operators	One operator	One bus operator has exclusive right to operate on busway.	Ease of control.		Appropriate for closed BRT system but otherwise limits options.
	Several operators	More than one operator permitted to operate on busway.	If several routes using busway, enables licensing of routes to different operators.	More difficult to control	More appropriate for open BRT systems.
Number of routes	Single route (with feeders)	All buses on busway operate between the same two terminals. Short routes link busway with points away from the busway; passengers must interchange between services.	Maximises busway capacity. Minimises passenger waiting times and therefore passenger capacity requirements at stops. Smaller buses can be used for feeders, providing more frequent service. Capacity/frequency can more easily be adjusted to demand.	Passengers must interchange. Interchange facilities require additional space.	Appropriate for closed BRT system.
	Multiple routes (no feeders)	Routes can converge on busway from outlying points (e..g. residential areas), and diverge to provide denser network in central areas.	More convenient service with no interchange.	Services on branches will be infrequent unless small vehicles are used for the entire route – which reduces BRT capacity and efficiency. Longer passenger waiting times necessitate increased capacity at stops.	Suitable for medium-level demand. In practice, more than ten routes on a corridor is not normally practical.
	Combination	Feeders serving areas of low demand, through routes where demand is higher.	Feeders can be operated on low-demand branches, with through services on high-demand branches.		In practice, often the best option.

Characteristic	Options	Description	Advantages	Disadvantages	Remarks
Spacing of stops	Closer		Improves passenger access to stops.	Reduces operating speed.	Stops should not normally be closer than 400m.
	Wider		Increases operating speed.	Reduces passenger access to stops. May require supplementary parallel bus services stopping more frequently.	
Fare collection system	Payment on vehicle			Requires on-board ticket issuing machines – possibly several on each bus. Easier for passengers to avoid payment. If fares collected by driver, increases boarding time to unacceptable extent for BRT. Passengers must pay separately for feeders if applicable.	Not practical for BRT. Through ticketing desirable for BRT where feeder services are operated.
	Prepayment at stop before boarding		Fast loading.	Requires ticket issuing facilities at every stop: expensive and requires maintenance if by machine.	Common on BRT systems. Through ticketing desirable for BRT where feeder services are operated
	Prepayment multiple journey		Fast loading. Convenient. May be used on feeders.	Passengers may dislike payment in advance.	Through ticketing desirable for BRT where feeder services are operated
	Contactless smart card		Very convenient. Permits more complex fare structure. Can facilitate subsidising certain groups.	Passengers may dislike payment in advance.	Now that technology is available, the most practical option.
Financial	Subsidised		Service more attractive to passengers.	Funding may be limited or inconsistent.	Efficiently run services should not require subsidy
	Not subsidised		Higher cost will deter passengers.	Service will be self-financing.	
Continuous/discontinuous busway	Continuous		Faster service	More expensive: busway may be unnecessary on some parts of route where road capacity is adequate.	Preferable where traffic volumes are very high.

Characteristic	Options	Description	Advantages	Disadvantages	Remarks
	Discontinuous		Less expensive. Buses can share road space with other traffic on roads where there is sufficient capacity not to require busway. May be the only option in city centres.	Subject to delay when sharing road space with other traffic. If buses are designed for busway, may not be able to pick up or set down passengers except on busway.	More flexible.
Power	Internal combustion			Higher local pollution levels.	
	Electric			Requires additional infrastructure.	May be justified where high volume of traffic, or if electric vehicles are used elsewhere in the system.

However, most modern BRT systems share several basic key concepts:

a) The designation of valuable city space for public transport in the form of bus-only streets, lanes or infrastructure for trunk routes.
b) The concentration of passenger demand at integration terminal "hubs" and the rationalization of supply in terms of trunk and feeder routes, along with new travel options at the Terminals in order to capture potential public transport demand. This allowspassengers in the city centre to generally take the first arriving trunk unit without waiting for a specific route number, which reduces the waiting queues. The waiting/station areas needed on the trunk sections are therefore relatively small.
c) Full accessibility to the entire system for a single ticket – or at least to the core urban zone.
d) Stations on the trunk routes set at longer intervals than conventional bus stops, typically 400–500 metres, preferably offering at-floor level, pre-paid boarding (as in a subway) to minimize loading times.
e) The use of high-capacity units on the trunk routes, with high-frequency services operating at about 20 kph (stopping routes) and 35 kmh on Direct Services with overtaking.
f) Electronic ticketing, preferably using contactless "smart cards".
g) Public sector planning, regulation and investment in infrastructure.
h) Private sector investment in fleet and operation, with a professional administration of the concession.
i) System design and building associated with civic improvements for pedestrians and general traffic.

Modern Bus Systems tend to be successful because their appeal has extended outward from the "captive" demand to a significant portion of the middle class. They look and perform much like modern metro systems, and there is no stigma attached to riding in them. This is essential for getting political, media and middle class support behind the transport project.

The economic benefits of BRT bus systems are indisputable:

a) These systems favour lower–income groups. Most urban road projects tend to favour higher-income car owners. In developing cities public transport normally has a captive or potential demand of low-income passengers. These benefit directly from investment in bus systems.
b) Travel times are drastically reduced on public transport. Passengers are often forced to spend several hours a day stuck in an overcrowded bus, facing traffic congestion, long waiting and boarding times and sinuous routes. Direct, high frequency, rapid transit can cut this lost time to a minimum.
c) Safety – especially for women – is improved at both the waiting areas and in the units themselves.
d) Road accidents tend to drop as pedestrian access is improved and units are separated from the traffic.
e) Emissions are drastically reduced.
f) As passengers gain new options of accessibility and reduce their time wasted on travel; the city gains in competitiveness.

(4) Conventional Buses

Conventional buses are the most flexible form of mass transport mode for urban operation. A bus can operate along virtually any road or city street where it is required, with minimal special infrastructure requirements. It may also operate on dedicated rights of way, or "busways", as BRT, as discussed above. Naturally there may be constraints on size: large buses may not be able to negotiate narrow streets in some parts of a city, or double decked buses may not be suitable due to low bridge heights or overhead cables, but because of the range of bus types and sizes which is available such constraints are rarely a major problem.

Buses are also flexible in terms of route capacity, which can be varied easily and quickly by changing the frequency of operation, by varying the capacity of the vehicles used, or both. Moreover, a new conventional bus route can be introduced with minimum investment.

Vehicle Size and Configuration

There are many options regarding the sizes and types of buses which may be operated on urban public transport services. These range from small vehicles such as the 15-seat *chapas* which currently provide the majority of services in Maputo (but preferably operated on a more formal basis), to large articulated single-deckers or double-deckers carrying over 100 passengers and in some cases up to 250 passengers or more on a single bus.

There is no single ideal size or configuration for a public transport vehicle. Small vehicles are most appropriate in certain circumstances, for example where roads are narrow or poorly surfaced, or where demand is low so that a larger vehicle would be only partly filled. However, small buses are less efficient in their use of road space in congested areas than larger buses. One large bus takes up a similar amount of road space to two small *chapas*, but can carry approximately five times as many passengers. If labour costs are high, the increased number of drivers required to operate a fleet of small buses, compared to larger vehicles, may result in significantly higher costs.

Where demand is very high and road conditions are good, the most efficient type of vehicle, in terms of cost and the use of road space, is normally the largest which can be legally and safely operated on the route concerned. On routes with poor road conditions or low demand smaller vehicles are more appropriate, to cope with road conditions in the case of poor roads, and to enable higher frequencies to be provided in the case of routes with low demand. In a large urban transport system, consisting of many routes with different characteristics, a mixed fleet comprising buses of various sizes is therefore usually appropriate.

There is also a choice between different vehicle configurations. The principal choices involve the proportion of seated to standing passengers, the number of entrance/exit doors, floor height, whether rigid or articulated, or single or double-deck. The most appropriate choice will depend on circumstances. For example, on long routes it may be desirable for all passengers to be seated although this will reduce the capacity of the vehicle and therefore increase the cost per passenger; where road conditions are poor, a high-floor bus may be necessary to avoid chassis damage; where roads are wide and straight and in good condition an articulated bus may be suitable; overhead obstructions may prevent the use of double-deck buses but if a high proportion of seated passengers is required this may otherwise be the best choice for long and busy routes.

At present the roads in Maputo are generally poor, as is traffic management and control of parking. Initially, therefore, rigid single deck buses of approximately 12 metres in length, with medium height floors, two or three passenger doors for entry and exit, and capacity for approximately 35 seated and 65 standing passengers, are likely to be appropriate as the standard

for trunk routes; rigid single deck buses of approximately 8 metres in length, with medium height floors, one or two passenger doors for entry and exit, and capacity for approximately 20 seated and 30 standing passengers, may be suitable for feeder routes. Whatever the final specifications, however, the models selected must be sufficiently robust to withstand local conditions, and it is essential that spare parts for them are readily available in Mozambique.

When road conditions and traffic management in Maputo improve, it will be possible to introduce larger buses on trunk routes, and low-floor buses providing easier access will also become more practical. Increased use of articulated buses on the busiest routes should be considered (TPM already has a small number, but most are unserviceable), and double-deck buses carrying a high proportion of seated passengers may be considered for the longest routes such as those operating between Maputo and Matola. Very large buses may not be practical in the short term since they require longer times at bus stops, but when more advanced fare collection systems become practical, boarding times may be reduced, enabling bus sizes to be increased.

The introduction of larger and more efficient buses to replace the existing small vehicles will reduce the current total requirement of buses in Greater Maputo to between approximately 1,000 and 1,500 if they are efficiently utilised. Total operating costs will be reduced substantially, provided that appropriate models are selected, an effective preventive maintenance programme is implemented, vehicle utilisation is optimised and the number of staff employed is no more than adequate to manage and operate the service.

While the total number of people employed in the transport industry will be reduced through replacement of small buses by larger ones, the benefits to be derived by the population of Maputo as a whole from a more efficient and cost-effective service will outweigh the disadvantage (which may be temporary in most cases) to those who will lose their employment. It must be remembered that the primary role of a public transport service should be to provide the best service at lowest cost. If it is treated as a means of creating employment, this requirement will never be achieved.

Propulsion Options

The type of propulsion is another important consideration, and the advantages and disadvantages of the alternative sources of power must be carefully assessed before commitment to any particular one. The basic options are diesel or gasoline, compressed natural gas (CNG), electric power or hybrid vehicles using two sources of power. In general, gasoline is impractical for public transport vehicles, due mainly to the cost: a gasoline engine consumes up to twice the amount of fuel required for a diesel engine for the same number of kilometres. CNG is becoming more widely used in some countries, but there are problems of availability (which will decrease as this fuel becomes more widely used) and there are also technical problems: for example CNG engines are prone to overheating, particularly in hot climates, and this could be a problem in Maputo: TPM already has a substantial number of gas-powered buses, manufactured in China, which have proved to be less reliable than diesel-engined buses.

Electric power for buses is at present only practical using a power supply from overhead cables; battery technology is insufficiently advanced to permit the widespread use of batteries as a sole source of power. Some buses are being developed which use a combination of diesel engine and battery, but the technical development is still at an early stage.

There have already been proposals for the introduction of trolleybuses (electric buses supplied with power from overhead cables) in Maputo. Trolleybuses have been in operation in various countries for over 100 years, and have various advantages over conventional buses powered by

internal combustion engines. These include an approximate doubling of energy efficiency, reduced vehicle maintenance costs and extended life, good acceleration characteristics, low noise levels and zero exhaust emission. On intensive, high-frequency services the cost of the overhead power equipment and other infrastructure is spread over a large number of users, and can give this form of propulsion a clear cost advantage over conventional buses. Trolleybuses can be introduced on a route-by-route basis, and can operate alongside other buses, thus providing flexibility for implementation.

Disadvantages include vulnerability to irregularities in the electricity supply (which at present would be an important consideration in Maputo), increased infrastructure maintenance requirement, lack of routing flexibility (for example if there is a need for traffic to be diverted because of road works or other obstruction) and visual intrusion of the overhead cables.

In particular, because of the infrastructure required, in terms of generating capacity and overhead equipment, there is a minimum level of operation for viability. However, there are several routes in Greater Maputo, particularly potential BRT routes and other main traffic corridors, where passenger volumes are sufficiently high to justify a more thorough assessment of the potential benefits of trolleybuses.

As technology improves, and the ability of local bus operators to maintain vehicles to a higher standard improves, the introduction of cleaner sources of power, such as CNG or electricity may be considered. It must be pointed out, however, that some of these clean power technologies are still developing, and the costs and other disadvantages must be carefully considered before experimenting with such vehicles. It is preferable to wait until technologies have been fully developed and proved in operation in other countries before contemplating their introduction in Maputo.

(5) Water Transport

Even with construction of the Catembe Bridge and other potential developments such as a bridge to replace the ferry at Marracuene, there is likely to be a continued, though small, role for water transport in Greater Maputo. It is already estimated that the capacity of the Catembe Bridge will be inadequate to cater for the requirements generated by the Maputo Sul development, so that there will be a continuing need for complementary ferry services between Maputo and Catembe.

Transmaritima sees only limited potential for high speed passenger services between Matola and Maputo, or for other water-borne transport services linking points along the coast as an alternative to road transport, due to the inconvenient location of the terminals; they do not think there are suitable sites for more convenient terminals, and the cost of land acquisition and construction would be high. Nevertheless they envisage a potential role for small vessels carrying 60–80 passengers, which could provide relatively fast point-to-point services. There was a recent plan for a new service from Maputo to Costa do Sol, but this was abandoned since sea conditions are unpredictable and it was considered that the service would not be viable.

Water transport will never become a significant component of the urban transport system in Greater Maputo, but where there is potential for a viable service it may be appropriate for the local authority to make the necessary infrastructure and other facilities available to private sector operators, either on a fully commercial or subsidised basis.

(6) Informal Public Transport Modes

Informal public transport services are those which are provided by private individuals or small groups of individuals, typically owning only one vehicle, in a deregulated environment. Typical

informal road transport modes are minibuses, represented in Mozambique principally by the *chapas*; three-wheel motor cycle- or scooter-based vehicles, such as the *txopelas,* informally operated full-sized buses, and taxis.

In many developing countries a relatively recent addition to this list has been the motor-cycle taxi, normally relatively small motorcycles carrying one (but often more) passenger on a fare-paying basis. Motor-cycles are relatively cheap and readily available, and have become very common in many African countries as a means of catering for unsatisfied passenger transport demand. In large Nigerian cities, for example, there are many thousands of such vehicles, creating serious problems of traffic congestion and pollution, as well as being perceived as a serious security threat. Attempts to control or ban them have been largely unsuccessful, since their owners have become a large and powerful group. Motor-cycle taxis have not yet appeared in Maputo, but unless the existing public transport capacity shortage is remedied soon, there is a risk that they will do so, and add to the disorder on the city's streets.

Informal public transport is becoming increasingly significant as an urban transport mode in developing countries. The informal transport sector has flourished for a number of reasons. The vehicles normally used are relatively easy to purchase, operate and maintain. It is possible to buy ten or more second-hand minibuses for the price of one new large bus. Maintenance of small vehicles is easier for a small operator: many of the parts are common to those of cars or light trucks and are therefore readily available, while maintenance skills for small vehicles are more widespread. A minibus requires relatively little special skill to drive compared to a full-sized bus, and often no special driving licence is required, so that drivers are more readily available, and cannot usually demand high salaries. Finally, regulations governing their operation tend to be relatively ineffective. Motor-cycle taxis are particularly accessible to potential entrants into the informal transport sector.

These factors, as in most cities in developing countries, have resulted in the predominance of small informal vehicles in Maputo, despite their unsuitability for mass transit. It has been argued that informal services are more appropriate than conventional bus services in developing countries. They are often seen by passengers as being quicker, more convenient and more comfortable; they can provide flexibility, and a wider coverage than ordinary buses, although fares are usually higher. They are usually highly competitive, and up to a point, the laws of competition ensure that the service provided is matched to passengers' needs. Finally, where unemployment is at a high level, the informal transport sector has the added attraction of providing jobs: in some countries, such as Liberia, the ownership of informal public transport vehicles, including motorcycles, has been actively encouraged by government as a means of providing employment to ex-combatants in recent civil wars, who might otherwise resort to criminal or other disruptive activities.

However, as is the case in Maputo, informal transport services have a number of serious disadvantages, particularly in terms of the quality and safety of the service provided, and their effect on other traffic in congested areas.

Because of the lack of effective regulation, the types of vehicles used by the informal sector, and their numbers, are often wholly inappropriate to the requirements of the travelling public. This will require a progressive replacement of unsuitable vehicle types by more appropriate types, and, where some informal vehicle types may be permitted to continue in operation, their numbers should be strictly controlled. This will apply in particular to the taxis and txopelas, which may continue to complement the formal scheduled bus services, but on a controlled basis.

These are issues which must be addressed through formalisation of the public transport industry, and the replacement of unsuitable small vehicles by more suitable ones. However, this will raise

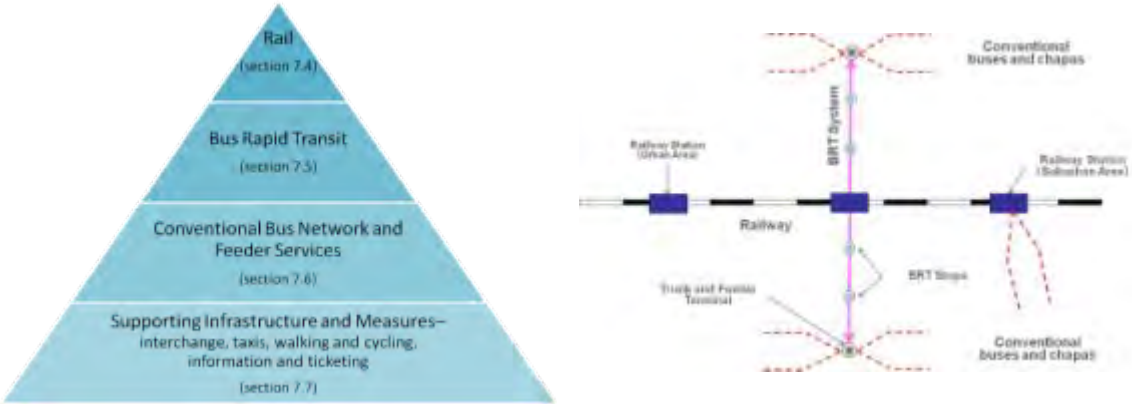
another major issue, namely the effect on the thousands who depend on the informal sector for their livelihoods. This is discussed later, in the context of the restructuring of the public transport industry.

F.2.4 Recommendations

To achieve the urban transport development vision and realize the above policies for public transport, a step change in provision is required through implementation of a comprehensive and integrated public transport network including mass transit provision. To this end a wide range of options are available. Characteristics of each mass transit mode are described in the following sections, but the recommendation combination of modes must be based on estimated demand and cost performance as well as potential for taking advantage of land availability.

The mass transit network forms part of the Master Plan's integrated public transport network. The development of this public transport system considers how different modes contribute different parts of the public transport offering to meet Greater Maputo's needs. This is best represented as a public transport hierarchy (see Figure F.3), from commuter rail for the longest journeys through BRT to local bus and finally walking and cycling for the shortest journeys.

Later, Section F.4 outlines the proposals for each in turn.



Source: JICA Project Team

Figure F.3: Greater Maputo Public Transport Hierarchy

F.3 Public Transport Route Network

F.3.1 Existing Situation

There are approximately 130 *chapa* routes in Greater Maputo, most of which are between 9 and 30 km long. However, because of the extent of illegal operation by unlicensed vehicles, a number of routes which are not operated due to poor road conditions or inadequate revenue potential and the practice of "route-cutting", the route details held by the municipalities cannot be relied upon as wholly accurate.

Public transport routes are not formally planned. Operators, through their associations, initiate new routes or, more commonly, extensions to existing routes. Typically, a few *chapa* operators will initially try out a new route or extension on an experimental basis, and if successful, the association will propose the change formally, and licences will be amended accordingly. In some cases, the municipality identifies routes which it considers to be required, or local communities may request a route by approaching the municipality. However, often these routes are unpopular with operators (mainly because of low demand, poor road conditions or both) so

that some are served by only a few vehicles, while others are not served at all. Under existing regulations, it is not possible to force an operator to run on a particular route. In effect, therefore, the operators decide on the routes to be provided.

The current licensing procedure is for a bus or *chapa* owner to apply to the relevant authority for a licence to operate the vehicle; the authority will issue a licence which specifies the route on which the vehicle must be operated. In practice the owner requests the route for which the licence is to be issued. The authority does not take into account the number of vehicles already licensed for a route when it issues additional licences, so some routes have excess capacity and others not enough. In reality there are also illegal operators who operate without licences on routes of their own choosing.

Licences are administered by Central Government for inter-provincial services, by provincial government for intra-provincial services and by municipal government for urban public transport services.

F.3.2 Issues

(1) Network Planning

The public transport route network in Greater Maputo has developed piecemeal over many years, and is based largely on the network originally operated by TPM, with additional routes added from time to time. In recent years there have been very few changes: the decline in the total number of vehicles available has precluded the introduction of new routes, and the level of service on many existing routes is reported to have been reduced.

Combined with a shortage of planning expertise and inefficient operating practices in the transport industry, this has resulted in a route network which no longer meets the travel requirements of citizens in the most convenient, efficient and cost-effective manner.

Improvements to public transport proposed under the Master Plan, including the possible introduction of BRT and urban rail services, will necessitate substantial changes to the route network in order to maximise the efficiency of the system. It is therefore necessary to redesign the network as part of a fully coordinated urban transport system to ensure that present day requirements are met as effectively as possible, and to make optimal use of vehicles. This will require an extensive origin-destination study, which is beyond the scope of the present study.

It is also necessary to develop the expertise required to update the network continuously in future, to meet changing requirements and circumstances.

(2) Accessibility and Route Coverage

Most routes operate from terminals near the centre of Maputo or Matola to outlying points; there are no services operating across the centre of Maputo, limiting the number of options for through journeys across the city centre. The preference for shorter routes results in increased idle time at terminals, which reduces vehicle productivity.

Public transport services to several outlying areas are poor. Not all planned *chapa* routes in Matola are operated: some are unattractive to operators because of poor road conditions and fares are insufficient to cover costs. In Marracuene, roads in some villages are in poor condition, and have no public transport service. Some people must walk for up to seven kilometres to reach the main road to take a bus; where buses or *chapas* do operate, services are limited, and on some routes there is no service in the evening. In Boane, there are several communities,

including Massaca, Chinonanquila, Mahubo and Djonissa, which have little or no public transport service.

In addition, the informal bus operators prefer the more profitable routes, so that those where demand is low tend to be poorly served. The practice of route-cutting further reduces the effectiveness of the network.

(3) Choice of Service

On some routes passengers have the option of using *chapas* or TPM buses, but the frequency of service provided by TPM due to its shortage of buses is so low that in reality the choice is very limited. TPM charges lower fares, but the quality of service is similar, with both buses and *chapas* regularly overcrowded.

Taxis are the only alternative for those passengers requiring a higher standard of service, but the fare is considerably higher. On high-volume routes there will be potential demand for a higher quality bus service, offering better comfort including possibly air-conditioning and no standing passengers, at a fare sufficient to cover the cost of providing the service, which would be much lower than the taxi fare. Such "premium" bus services are common in Asian cities, but very rare in Africa: however, if a formal, well organised basic bus service is to be provided, there will also be scope for a network of premium bus services.

The premium network would be less dense than the basic network, and would serve the higher-income areas. The routes may not duplicate the basic routes exactly, since the origins and destinations for higher-income passengers will tend to differ.

(4) Response to Demand

None of the bus or *chapa* services respond effectively to variations in demand. The "fill and go" operating practice of the informal sector means that frequencies are higher when there are more passengers boarding at terminals, but this does not take account of passengers wishing to board en route: some drivers leave terminals with partial loads at busy times, but there is no accurate means of matching the level of service to the demand. The practice of "route cutting" described later makes the situation worse.

All TPM buses operate the full length of the route: there are no "short workings" to cater for demand characteristics along the route, although this practice would enable the service to be improved. For example, at the Entreposto bus stop at the intersection of Av 24 Julho and Gare Popula, during the afternoon peak, there are regularly long queues of people awaiting buses heading out of town; there are also many people waiting for buses heading into town, most of whom are intending to remain on the bus at the terminal for the outward journey, in order to be sure of getting a place – but this reduces the availability of places for passengers waiting at the terminal, as well as increasing the travelling time and cost for these passengers. TPM could turn buses short to commence at the Entreposto stop to deal with this situation, providing an improved service and better vehicle utilisation.

More demand-responsive routing, scheduling and operating practices will significantly improve service capacity and convenience, but can only be implemented with a formalised system.

(5) Route Licensing Arrangements

While the present system has resulted in the provision of a transport service which meets most requirements, there are a number of deficiencies in the system, and it is desirable that the roles

and responsibilities of the operators and authorities respectively should be more clearly defined, and that the parties concerned discharge their responsibilities effectively.

In particular, there needs to be an effective system for ensuring that all planned routes are operated, with the required number of appropriate vehicles, and to specified schedules and standards.

Without such a system, effectively enforced, the benefits of the route network planning exercise will not be achieved.

F.3.3 Options

(1) Planning the BRT System

There are no hard and fast rules – or "tool box" – for designing a modern BRT System of the Latin American type. Each city is always a separate case study with its own characteristics and needs. Experience has shown, however, that there are certain basic steps that have to be carried out in any pre-feasibility study.

Step 1: City Structure

The first step is common to all projects: a close examination of the city's structure. This involves an on-site investigation of: the street layout, the location of residential, commercial and industrial areas; the general behaviour of the traffic; the scope of the current public transport network, the quality of road paving, sidewalks, urban design and the scale of the city in terms of density, buildings. This information is normally noted on maps and in digital photographs. At this stage the professional team should be keeping an open-mind and simply form a mental picture of the urban area and the immediate surroundings.

Step 2: Base Data

The second step is again common to all projects and involves the collection of data on: the current public transport system and its recent history (fares, new routes, etc.); population/census figures and income levels; development (Master) plans and proposed short-term highway/road projects; existing studies on similar systems (light rail, guided bus, etc.), as well as obtaining good maps of the urban area – preferably updated and in digital format – and aerial photographs – preferably at the 1:8000 scale.

A general rule for busway planning to "design short-term, think long term", i.e., use the existing demand data (all modes, but preferentially from the public transport system) as a basis for design, but check that these designs are compatible with the longer term planning strategy.

Step 3: Identify Existing Demand Constraints

The third step is to check on the existing demand constraints for BRT. These can expressed in terms of a viable passenger demand envelope, which for a 7 metre, 2-way busway, with stops every 400–500m, is about 30,000 (minimum) and 200,000 (maximum) pax/day (both direction) on the most loaded stretch. This corresponds to minimum peak headway for articulated units of about 5 minutes (greater headways are difficult to justify and to enforce the dedicated road space); and a maximum headway of about 60 seconds (below which the operation of the station platforms becomes complicated even with overtaking).

Step 4: Examine Physical Constraints

The fourth step is to examine the physical constraints of the city road system in terms of width; continuity; turning movements; accessibility; available land; interchanges; parking; lateral

access; pedestrian access; etc. Conventional bus priority tends to be restricted to the existing road network or even the existing one-way systems. Planning a modern BRT link, on the other hand, requires more "lateral thinking" in terms of the use of city space and other options, such as railway right of way, river valleys, private land, street markets etc.

Step 5: Examine Existing Public Transport Network

The fifth step is the examination of existing public transport (bus) routes to see if these can be "rationalized" into a common trunk route section and additional feeder routes. An interchange at a convenient location near this point would allow passengers from the feeder routes to change to the trunk route, as well as to other options of travel. The areas chosen for interchanges should thus create trunk route corridors with high passenger loadings (within the demand envelope) as well as good access for other route options, specifically interdistrict routes that link several corridors and important destination zones, without going through the city centre.

It is common to hear that these Interdistrict Routes – because they do not already exist – will have "no demand". In practice, such new circular routes have proved to be highly popular in many cities.

Step 6: Compare Physical Constraints with Corridor Demand

The sixth step is to compare the physical constraints with existing high corridor demands. Where the two coincide, a modern BRT system may be feasible in terms of space and demand. If the existing "captive" demand element is of major importance, the basic corridor demand can be obtained through a survey of passenger loadings at intervals along the corridor.

Step 7: Examine Other Constraints on Corridor Development

The seventh step involves an examination of other constraints such as green areas, historical (listed) buildings and other environmental factors. Part of this process should also consider problems related to urban blight, abandoned or wasteland sites, and redevelopment policy. BRT planning should take a broad view of the city and consider the possibilities of: using new infrastructure, opening up new corridors, using bus-only streets or including busway infrastructure in new city redevelopment.

Step 8: Identify Planning Considerations for Bus Interchanges

The eighth step is a check on how the interchange facilities will interact with the city land use plan and its desired future growth. New housing areas can be serviced from the interchanges by extending a new feeder route - without adding a new route for this development (thus overcrowding the city centre and other major destinations, nor extending an existing route and thus creating a huge oversupply of capacity on the last few kilometres).

Step 9: Define the Busway System

The ninth step is to determine the integrated BRT network. This uses conventional transport planning evaluated by means of modelling techniques. This design concept can be, and often is, modified during the final design.

(2) Bus Route Network Options

There are many ways of configuring a route network to meet passengers' requirements, all with their advantages and disadvantages: what is appropriate in one city may be unsuitable in another.

In most cities, the majority of passenger movements are radial: most demand is for travel from outlying points to the centre and return. There are also other movements, for example between

suburbs, but these are generally less significant. The main public transport routes therefore tend to radiate outwards from the central area, with branches from these routes to serve points on either side. The number of these branches will be partly influenced by the nature of the road system, and by policy and market forces: if people are not prepared to walk long distances, public transport routes will need to penetrate further into residential areas than otherwise. Similarly, if there are parallel roads along a corridor, a decision must be made as to whether to concentrate all routes along one road, or to split them between the two roads. The first alternative will give a higher frequency of service, and therefore less passenger waiting time, but a greater average walking distance, and perhaps increased traffic congestion on the route in question; the second will give a lower frequency, longer average waiting times but shorter average walking distances.

The size and layout of a city will affect the route structure. For example, if the central business district lies along a waterfront the scope for cross-city routes is reduced. If roads are laid out in a grid pattern, this will limit the scope for radial routes: some radial routes will involve frequent turns at intersections, leading to delays; the pattern of bus routes may therefore comprise straight routes following the grid, so that many passengers' journeys will involve one change of bus. In a city with a population of approximately one million or more the central area will normally cover a large area so that passengers' destinations are widely dispersed; where the distances between these exceed acceptable walking distances, it is inappropriate for all routes to converge at a single focal point. There may therefore be several points, each constituting the focus of a number of radial routes, and possibly requiring a sub-network of routes connecting them: these routes may be formed by linking two or more radial routes, while several of the routes may be able to serve more than one centre. This will also apply in a conurbation comprising two or more contiguous cities, each with its own distinct centre.

An important choice to be made is whether all routes should terminate in the city centre, or continue across the central area to an outlying point on the opposite side of the city, in effect linking pairs of radial routes to provide diametric cross-city routes. Alternatively, routes may terminate on the periphery of the central area, either on the near side (i.e. on reaching the edge of the central area), to minimise the effects of congestion, but requiring many passengers to walk to complete their journeys, or on the far side (i.e. after crossing the central area), providing a better service to passengers, but with increased problems of traffic congestion. Provision of bus priority measures to enable buses to cross the city centre with minimum delay will reduce the problems, and may make more efficient use of scarce land than providing off-street terminal facilities. A third option is for routes to operate in a loop around the central area. Where virtually all passengers travel to and from the city centre, and rarely travel between one outer suburb and another, the decision as to whether routes should terminate in the city centre or not is a purely operational one. If there are very large numbers of passengers boarding or alighting at the same point an off-road terminal may be desirable to avoid causing obstruction of other traffic.

A disadvantage of routes terminating in city centres is that buses can cause congestion whilst standing between journeys and when making turning movements; often valuable land is occupied with bus terminal facilities; time is wasted by buses turning round, with consequent reduction in bus utilisation and therefore increased costs; and passengers wishing to travel across the city centre will have to change buses or walk for part of their journeys.

Disadvantages of cross-city routes are that schedules are more likely to be disrupted by congestion, since there is no provision for recovery time in the city centre as with buses terminating there; interchange between routes may be less convenient than at a common terminal although this may be done at roadside bus stops instead; scheduling and fare structures are more complicated; crews must take breaks away from the central area; and, depending on

the type of fare structure, revenue may be reduced due to a reduction in the number of passengers transferring between routes.

On balance, the advantages of operating routes across the city centre usually outweigh the disadvantages.

Non-radial passenger movements can be catered for in a number of ways. In a large city, it is often appropriate to operate a number of routes linking various suburbs, and not reaching the city centre, perhaps including one or more circular routes linking outer points; often these are operated by smaller vehicles than those used on routes serving the city centre. Sometimes inter-suburban movement can be catered for by extensions or diversions from the main radial routes; this may have advantages in terms of vehicle utilisation, but may mean that longer-distance passengers are crowded out by short distance passengers, while deviations from the direct route add to journey times and cause inconvenience to through passengers. They may also leave portions of the main road corridor without a bus service, or with only a low frequency service.

A transport network may include a number of "feeder" bus routes, which feed passengers into trunk bus routes and to rail lines. These offer an alternative to operating a large number of different routes along a common corridor, each branching off to serve points off the main route. Through bus services should normally be operated where demand from the outlying points is sufficient to justify them, but where demand is low, it is often more economic to operate feeder services, using smaller vehicles. Also, where road conditions preclude the use of larger vehicles over part of a route, it is usually preferable to operate small vehicles on this section, feeding into a service using larger buses for the main section, thus eliminating the need for small buses operating inefficiently alongside larger buses on main urban routes. Similarly, it may be appropriate for feeder bus services to connect with rail or BRT services on trunk routes.

Feeder routes may meet a trunk route head on at the terminal point for the latter, or may connect with it at an intermediate point; in some cases the feeder may run parallel with the trunk route for a short distance.

The bus routes themselves may take various forms. The basic and most common type of route is the "end-to-end" route, which operates between two points, following the same roads in both directions, except where one-way street systems necessitate minor deviations. Alternatively, a route may be circular, returning to the point of origin without traversing the same roads twice. Circular routes are often found in suburban areas, sometimes circling an entire city; "inner circle" routes around city centre areas are more common.

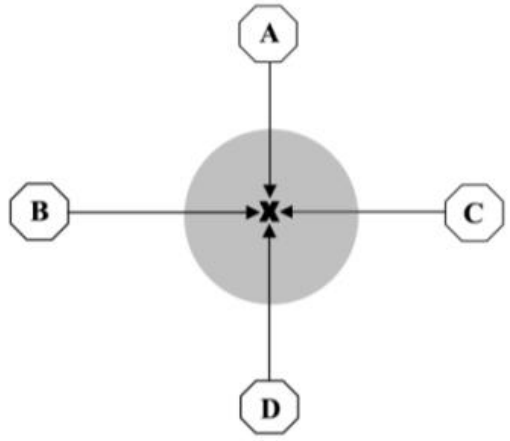
Another option is a route combining straight and circular sections, so that at the end of the route the bus, instead of turning and returning by the inward route, operates in a loop, rejoining the inward route after completing the loop, stopping in the central area for no longer than is required to set down and pick up passengers. Such an arrangement can be particularly effective for a central business district as an alternative to operating across the city centre: it can provide better service coverage than a terminal operation since passengers are able both to join and leave the bus throughout the circuit, enabling buses to serve a wider area than would otherwise be the case, and eliminates the need for city-centre terminal or turning facilities.

Another variation of the straight route is one which forks near one or both ends, to serve different terminal points; often these are regarded as separate routes, even though they operate in common for most of their length. Some routes may be "dumb-bell" shaped, with a loop at each end: these are normally found where buses operate across the city centre from one suburb to another, and operate in a loop around the residential areas at the outer ends.

Where buses operate in a loop at one or both ends of the route, all buses may traverse the loop in the same direction, or alternate buses may traverse it in opposite directions; the choice will depend partly on the size of the loop and frequency of service, and on the need for bus priority measures. It is normally more appropriate to operate in both directions; this optimises the service from all points around the loop since no passenger will have to travel more than half way round the loop. However, if the loop is so small that there is little difference in travelling time for any passenger in travelling in one direction instead of the other, it is normally preferable for all buses to operate in the same direction, so that passengers will always know from which direction the first bus will come. Similarly, if the frequency is low, it may be preferable to run all buses in the same direction, since alternating them will result in even lower frequencies. An advantage of one-way operation is that infrastructure such as passenger shelters at bus stops, or any bus priority measures such as bus lanes will be required on one side of the road only. If this option is chosen, buses should preferably operate in the direction with the shorter running time; this will normally be anticlockwise where traffic drives on the left side of the road, so that the number of turns across oncoming traffic will be minimised.

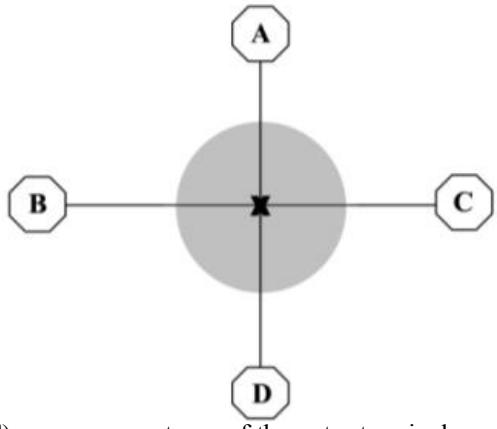
A route network may comprise routes of several or all of these types; each route may be planned in isolation, as is often the case where there are many different operators, or all may be planned as a co-ordinated network. There are various ways in which bus routes may be combined to form a network. For example, the main road system of a small town may consist of two roads, both served by buses, intersecting at right angles at the city centre. The bus routes may be configured in different ways: as two straight, diametric cross-town routes, crossing at the intersection; four radial routes, all terminating at or near the intersection; or up to six cross-town routes, all passing through the intersection, so that most or all pairs of outer terminals are linked, with up to four routes making a right angle turn at the intersection, and two diametric routes crossing at right angles. These alternatives are illustrated in Figure F.4, Figure F.5 and Figure F.6. The routes need not all be of the same length: in order to provide higher frequencies towards the town centre, some buses may be turned short of the outer terminals. This can be achieved by introducing intermediate turning points on each leg of the cross, and dividing each leg into sections.

Thus there are various degrees of complexity for an urban route structure, even for a small and basic public transport system as in the above example. Complex route systems are generally practical only if services are reasonably reliable, and passengers have the confidence to wait for a bus on their particular route variant; if reliability is poor, they will prefer to board the first bus which arrives, and a much simpler route system is therefore desirable. More complex routes and route structures may make scheduling more difficult, and therefore the way in which services are scheduled is also relevant in planning a route network.



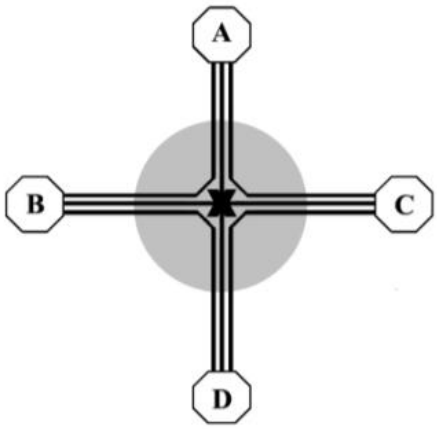
Each route commences at one of the outer terminals (A, B, C or D) and terminates at the Cross in the City Centre.

Figure F.4: Alternative Bus Route Configurations a: Four Separate Routes



Each route (A-D and B-C) commences at one of the outer terminals, crosses the City Centre and terminates at the outer terminal at the opposite side of the city.

Figure F.5: Alternative Bus Route Configurations b: Two Routes



Together with the routes crossing at the City Centre, routes A-B, A-C, B-D and C-D provide through services between all four outer points. If the frequency of service provided by each route is one third of that provided by routes A-D and B-C in the previous example, the combined service frequency along each leg of the cross will remain the same, as will the number of buses required to provide the overall service.

Figure F.6: Alternative Bus Route Configurations c: Six Routes

(3) Bus Service Options

Consideration should also be given to the quality of service provided. On some routes, such as those serving higher-income areas, passengers may be able to afford higher fares, and may be willing to pay more for a better quality service. There may be potential for the introduction of "premium" services, using better quality vehicles offering greater comfort and charging higher fares, in addition to "standard" services, using basic vehicles, operating at minimum cost and charging lower fares. The potential for such services in Greater Maputo should be examined. However, the basic network of formal bus routes should be implemented first, in order to improve the quality of service for the majority of passengers, and also to allow the operators to develop their expertise: passengers paying premium fares will expect an efficient and reliable service regardless of vehicle quality.

On long routes, such as Maputo-Boane, some journeys should be operated on a "limited-stop" basis, stopping only at the principal points, in order to minimise journey times for passengers travelling long distances. On heavily used routes, such as Maputo–Matola, some buses may be scheduled to operate non-stop between terminals. Buses operating on shorter sections of the route, stopping at all points, would cater for short-distance passengers. This requirement is already catered for to a limited extent by the TPM express routes, but there is potential for additional services.

Although the current practice of arbitrary route-cutting by chapa drivers is deplorable, it is rational to vary the service frequency on different sections of a route to match variations in demand. Typically, the demand for a bus route increases as it approaches the central area.

The frequency can be varied, or tapered, accordingly by scheduling some buses to operate over only part of the route; on long routes it may be necessary to provide terminal facilities at several intermediate points where buses may turn short. If several different routes operate along one corridor, branching off at various points to serve areas in the corridor hinterland, their frequencies can be coordinated, to some extent at least, to provide the requisite taper. Alternatively, different routes may be planned to terminate at a different point along the corridor, so that the combined frequency of the routes is increased towards the city centre. Whatever option, or combination of options, is selected, it is desirable to minimise the number of interchanges to be made by passengers.

The redesigned route network should strike a balance between the aim to maximise passenger convenience by providing direct links between origin and destination for the majority of passengers, and optimising vehicle utilisation. In some cases, therefore, it will be necessary for passengers to interchange during their journeys, for example from a small bus operating on a route where demand is low to a large bus operating on a main route: there must inevitably be some compromise but this should be kept to a minimum.

The route network should be based on the basic principles described above. It will be necessary first to conduct a comprehensive O-D survey for the entire Greater Maputo area, in order to determine exactly what the requirements are, not only to identify the routes themselves but also to determine the capacity required, and hence the number (and types) of buses. Where routes are to be linked across the central area it is also important to ensure that the capacity required on both sectors is broadly consistent: this in practice is likely to necessitate a route entering the centre from a busy corridor to be split and linked with two or more routes with lower demand entering the opposite side of the central area.

A preliminary exercise has been undertaken to identify potential routes through the central area in order to demonstrate the concept, but these must be tested and modified where necessary in

the light of O-D data when these are received, and taking into account comments from stakeholders, in particular from TPM.

(4) Requirements of Different Land Use Scenarios

The way in which Greater Maputo develops will influence the nature of its transport system, and the network of roads and public transport routes.

If the city continues to develop in accordance with the existing land use pattern, the requirement will be for a complex network of primary, secondary and feeder roads, and a corresponding hierarchy of public transport routes including radial, peripheral and suburban links. If the development trend is towards a series of discrete centres, a network of primary roads and public transport routes connecting the centres, supported by sub-networks of routes focused on each centre, will be more appropriate. If, on the other hand, development is concentrated along the main route corridors converging on the city centre, a system of high-capacity primary roads and public transport routes along these corridors, complemented by tributary or feeder routes, will be required.

The polycentric scenario, in which communities may live and work, and engage in other activities within a relatively small area of the city, will, in theory, reduce the requirement for transport: many people will be able to walk for at least some of their journeys. In practice, however, a significant number of people are likely to live in one area and work in another, and travel patterns will therefore be complex. Corridor development will concentrate travel demand along a limited number of routes: people travelling to and from the central area will travel along one of the corridors for the major part of their journeys, providing justification for multi-lane highways if private transport is allowed to grow substantially, or for high-capacity BRT, LRT or heavy rail systems if the focus is to be on public transport.

If the city's development includes both the polycentric and corridor models, as is likely, the road and public transport route network must cater for both. A substantial part of the public transport system will be road-based, and the inherent flexibility of this mode will enable it to meet all requirements, as well as to adapt as these requirements change, provided that it has the institutional capacity to do so.

Recommendations in respect of BRT and rail services on the main transit corridors are discussed elsewhere. These must be planned on the basis of assumptions regarding the likely development scenario for Greater Maputo, and will depend on whether this will follow the existing random land use pattern, a polycentric or transit-corridor model. The characteristics of the basic bus system which will complement rail or BRT services will depend both on the networks of these modes as well as on the urban development scenario, and therefore at this stage it is not possible to make specific proposals with regard to the bus route network, the number and types of vehicles which will be required, or the infrastructure requirements in terms of bus stops, terminals and depots.

However, as an urban transport mode the conventional bus is extremely flexible. Compared to modes requiring fixed tracks or dedicated rights of way it is possible to respond to changes in requirements relatively quickly by increasing or reducing the size of the fleet, introducing vehicles to different specifications, and making changes to routes and service frequencies. It is therefore unnecessary at this stage to attempt to predict the nature of the conventional bus system in the medium or long term. What is absolutely essential is to ensure that the bus industry in Greater Maputo has the resources and capability first to meet existing requirements, and second to adapt and respond to changes in requirements as they arise, whether these changes are due to changes in land use and demographics, developments in other transport modes or for any other reason.

The appropriate future public transport network will depend on the land use development scenario for Greater Maputo. This will determine the extent to which high-capacity mass transit modes such as rail or BRT will be required, and their route networks. The route network for the conventional bus system will, in turn, depend on the nature of the high-capacity mode network. Until the networks for these other modes have been finalized, therefore, it is not possible to design a route network for the complementary bus services. However, the flexibility of the conventional bus will enable the services to be adapted to complement the BRT or rail services as they develop; it is therefore necessary only to make recommendations regarding the immediate bus route network requirements, and (most important) to ensure that the bus industry in Greater Maputo has the capability and resources to adapt as necessary.

(5) Route Licensing Arrangements

The present licensing arrangements are unsatisfactory and must be changed. There are broadly two options: deregulation or a rigidly applied route licensing system whereby a network of routes is planned by the Transit Authority and operators are awarded licences to operate them.

Deregulation would worsen the present situation. More operators would migrate to those routes which are perceived to be most profitable, leaving a greater number with a low level of service, or none at all. Experience in other countries has shown that competition on the road resulting from a deregulated system never results in a satisfactory public transport system, and that a system is required which is planned and regulated, delivering the benefits of competition through a concession system which involves competition for the market but not in the market.

The only viable option is a route licensing system. This may take one of two basic forms. One is to issue licences for individual vehicles, specifying the route on which it must operate. This is basically the existing system, although it is not well enforced. Even with effective enforcement, however, there are two major disadvantages: one is the difficulty of ensuring that there is the appropriate number of vehicles on each route; and the other is the difficulty of ensuring that the buses on each route are operated to a schedule designed to meet varying demand at different times of the day, and on different sections of the route.

The alternative approach is to licence an operator to provide the entire service on a route. The Transit Authority would specify the number and type of buses to be operated, and the service capacity at different times and on different route sections. The operator would have to have the necessary number of buses, and the capability of operating them to the required standard. Similar arrangements could apply to other modes: the Transit Authority should award similar licences in respect of urban rail or ferry services.

The concept of a system based on concessions giving private sector operators the exclusive right to operate on a specified route has been part of Mozambique government policy since 1996, although no concessions have been awarded so far. FEMATRO has held discussions with the Ministry of Transport with a view to putting the policy into effect, and proposed the formation of cooperatives of existing owners to become the initial concessionaires: eventually these cooperatives could evolve into formal companies, eligible to hold concessions for several routes.

Existing regulations empower Government to award operators concessions to operate specific routes. To qualify for a concession, an operator must have at least two vehicles, a timetable, and must specify stopping places. Concessions give exclusivity to an operator on a route. The term "route" is not defined in the regulations: for example in reality several routes may converge on a common corridor and it is not clear whether this should be regarded as a single route with several variations or several separate routes. If the concession holder performs badly another operator may be given a concession to operate alongside the incumbent or may be appointed to replace the incumbent.

So far no concessions have been granted, so it is still possible to rectify some of the potential deficiencies in the legislation by developing more precise and specific regulations.

The details of such concessions must be carefully thought out before any firm contracts are entered into between the government and transport operators. There are a number of considerations. The first is whether concessions should be awarded by route, route group, area, or network: there are advantages and disadvantages to each approach. It may be appropriate to combine profitable with unprofitable routes in each concession; this "package" approach has merit but it is difficult to estimate the profitability or otherwise of each route and may lead to an inequitable allocation. In any case, the principle of cross-subsidy inherent in this approach brings its own disadvantages, and its implications must be considered fully. Initially, separate concessions for each route, with trunk and feeder routes treated as separate routes, may be preferable.

The duration of the concessions must be realistic. Current regulations specify a 20 year term, but a much shorter period is normally appropriate for a bus service concession: five years is more typical, and is more in line with the economic life of the vehicles used.

An important principle is that each route should be managed as an entity. This will enable the service to be scheduled in accordance with demand, for example with increased frequencies at busy times and reduced frequencies at less busy times, and perhaps tapered frequencies, with a higher frequency on the busier inner portion of the route than on the outer portions. This will involve some buses being used more intensively than others. If buses are individually owned, with each owner interested in maximising revenue, the allocation of some buses to duties which are more profitable than others can create problems, and in general, from experience in other countries, owners are unwilling to cooperate to provide such a scheduled service. For a properly organised service, therefore, each route must be managed as a whole, and this is best achieved by having only one operator responsible for an entire route.

Route licences should be issued on the basis of competitive bids. Potential operators would be required to submit proposals indicating their expertise and financial resources, and to prove their capability of managing the services in accordance with the specification provided by the Transit Authority.

F.3.4 Recommendations

It is recommended that a comprehensive route network study should be carried out to develop a revised route network to meet the current requirements of Greater Maputo. The network should be based on the following principles, although some exceptions will be necessary to cater for specific local requirements:

- Trunk and branch routes rather than trunk and feeders, except where feeders are necessary
- Minimum requirement for interchanges
- Cross-city centre routes, based on a system of loops, with network covering central area
- No terminals in central area
- Open BRT system
- Tapered frequencies to cater for demand variations along each route
- Express and limited stop services where appropriate
- Premium services where appropriate

In addition to identifying the appropriate route network, the exercise will include calculation of the capacity required for each route, the optimal bus type for each, number of buses required,

and service frequency. It will also be necessary to develop a phased plan for the implementation of the network and associated bus fleet changes. This must be coordinated with the process of restructuring the public transport industry as discussed above.

In parallel with the network planning exercise, it will be necessary to develop the required planning capability within the regulatory authority, and to develop the capability for both planners and bus operators to adapt to changes in requirements as they occur. It is essential that once the new network has been implemented, services and requirements are constantly monitored, and that routes and services are regularly adjusted to cater for changing circumstances.

Each bus route should be operated by a single operator, under licence from the Transit Authority. Licences would be awarded to suitable operators be means of a competitive bidding process.

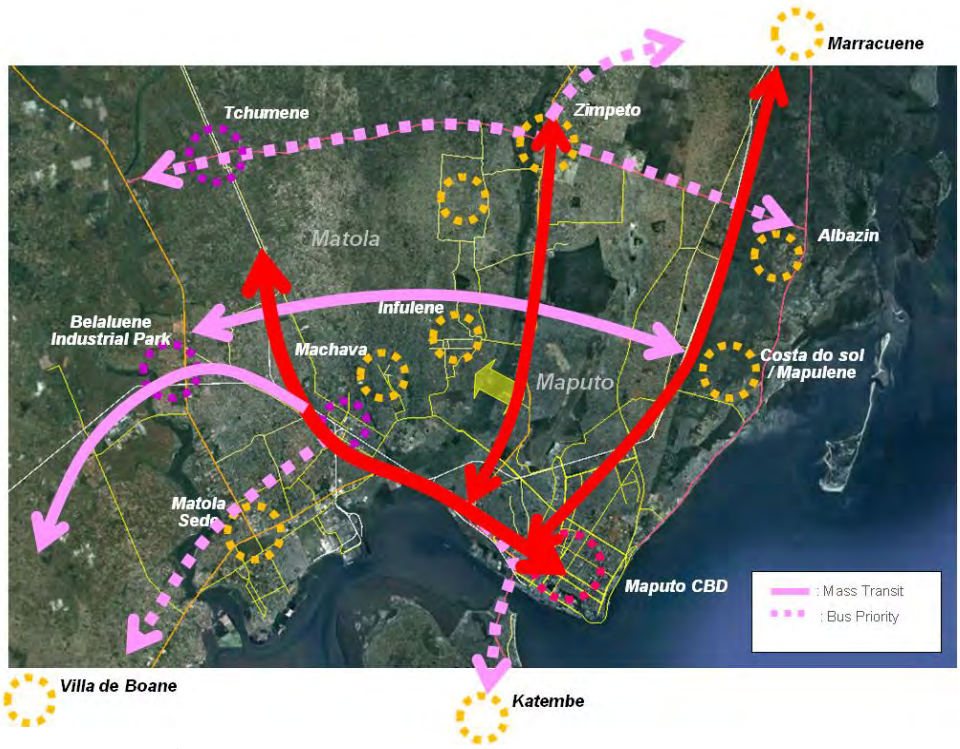
F.4 Route Network Concept and Proposals

The route network concept and proposals are now outlined covering the following:

- Key mass transit corridor and proposed systems
- Proposed Passenger Rail System
- Proposed BRT System
- Conventional Bus Network

(1) Key Mass Transit Corridors and Proposed Systems

Based on the future demand analysis, desire line patters for public transport trips are analyzed and key mass transit corridors are identified as shown in Figure F.7



Source: JICA Project Team

Figure F.7: Key Mass Transit Corridors for Greater Maputo

Table F.2 shows key characteristics of major mass transit systems. Based on the estimated demand and cost performance as well as potential for taking advantage of land availability, heavy rail and BRT systems are selected as main public transport systems for Greater Maputo.

Table F.2: Mass Transit Systems

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

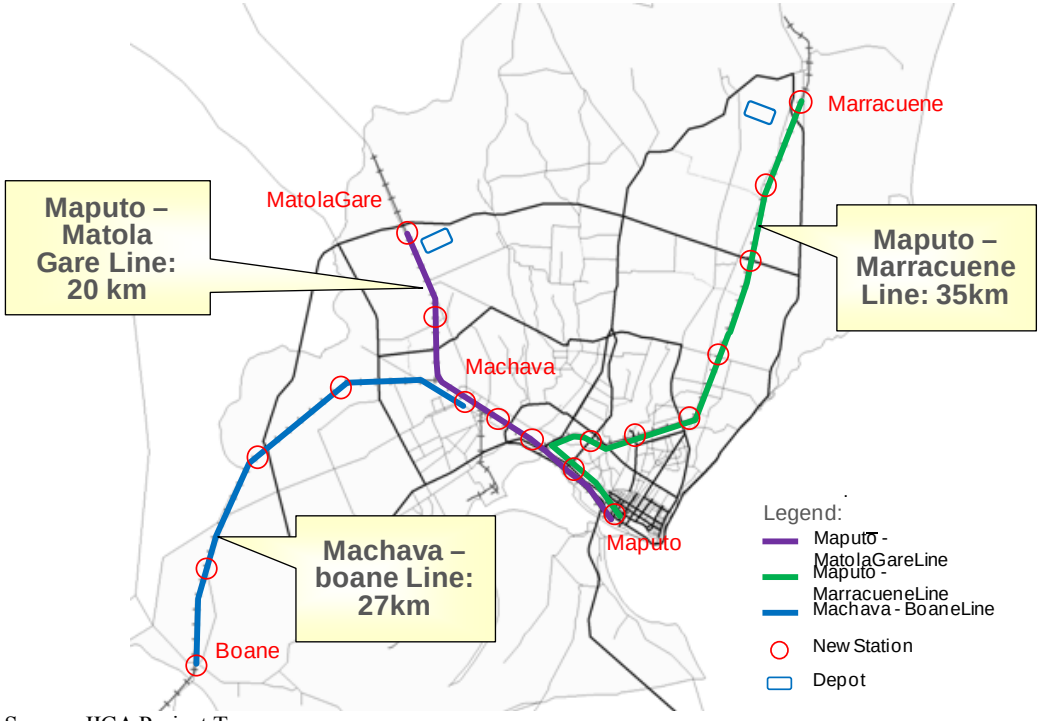
Note 1: Type of LRT in Hiroshima, Japan was considered; 2: 10 cars per train

As mentioned, the mass transit network forms part of the Master Plan's integrated public transport network. The development of this public transport system considers how different modes contribute different parts of the public transport offering to meet Greater Maputo's needs, as represented in the aforementioned public transport hierarchy (see Figure F.3). The following sections outline the proposals for each.

(2) Proposed Passenger Rail System

Overview

After surveying the existing situation of railway services in Greater Maputo, the JICA Project Team proposes the following three lines for the new passenger rail services (shown in Figure F.8), in order to minimize cost and to take maximum advantage of changes in the land use pattern.



Source: JICA Project Team

Figure F.8: Passenger Rail Network

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

Design Passenger Volumes

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

Maputo–Matola Gare Line

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

Maputo–Marracuene Line

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

Machava–Boane Line

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

(3) Proposed BRT System

Overview

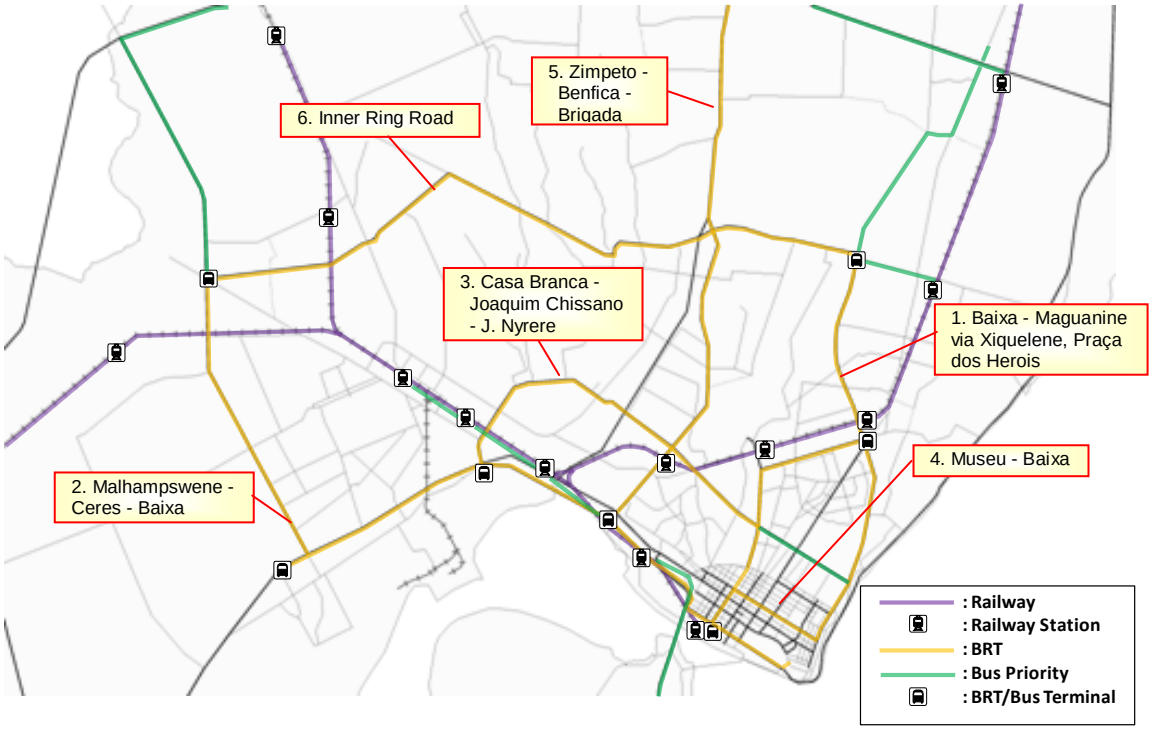
The proposed BRT system is a major component of the Master Plan. This form of low-cost mass transit has proved to be pivotal in many countries, aiding cities in moving away from the model of public company bus transport, with its associated problems (e.g., overstaffing, underfunding, problems with spare parts), and away from a poorly regulated private sector based on second hand minibuses.

BRT systems tend to operate on a "paid-by-the km" concession that guarantees a viable service contract and allows for capitalization of the system. The latest business models also incorporate the small operators that will lose their existing operating permissions as shareholders/ stakeholders.

This Master Plan and other studies in progress by the municipality, as well as experience elsewhere, indicate that high-capacity BRT has an important role to play in the development of Greater Maputo.

BRT Network for 2035

Figure F.9 presents the network structure of the proposed BRT system in 2035.



Source: JICA Project Team

Figure F.9: Proposed BRT Network in 2035

Table F.3 summarizes the BRT routes, complementary inter-district routes, and infrastructure. These complementary routes use will conventional units that link the main terminals without any special or additional infrastructure, such as bus ways.

Table F.3: Proposed BRT Routes for 2035

No.	Route	Route Characteristics	Length (km)
1	Baixa–Maguanine via Xiquelene, Praça dos Herois	Covers the high demand section between Maguanine/Xiquelene/Praça dos Herois and the Baixa. A busway 'spur' on Eduardo Mondlane will also offer services to the Museu area	12.9
2	Malhampswene–Ceres–Baixa	Important inter-municipal BRT Route that could be incorporated into the development plans of Katembe Bridge and the upgrading of the Toll Road. Essential for the success of all TDM as it offers a premium alternative to the high car usage between Matola and Maputo	21.2
3	Casa Branca–Joaquim Chissano–J. Nyerere	Covers the high demand section between Machava and Xiquelene. Operational studies will determine how this will access the main Machava demands	13
4	Xiquelene–Museu–Baixa	Extension of the Museu spur route that can offer an alternative to the highly congested Vladimir Lenine Binary for passenger demand coming from Xiquelene	10
5	Zimpeto–Benfica–Brigada-Baixa	The N1 corridor can be transformed into a fully urban Avenue with BRT standard transport. This route is essential to alleviate congestion and performs an important social role. The construction of the new 'Green' line highway would offer an alternative for through traffic	16.2

No.	Route	Route Characteristics	Length (km)
6	Route 1 Extensión: Albasine–Via Cardeal A Santos	When the feeder demands at the end of a BRT route become too high, BRT routes are normally extended by the addition of a new terminal and busway track. This option thus offers a better service at a lower cost for passengers.	6
7	Katembe Extension	During the first decades of urban expansion following the opening of the bridge, it will not be possible to serve all the residential zones with bus services, thus a simplified form of BRT - with priority on the bridge and access roads - and integrated into the full BRT system will be needed. This will have feeder bus and park and ride facilities.	11.8

Source: JICA Project Team

Modelled Demand

The modelled passenger demand data for the year 2035 indicates that for the Phase 1 corridors the maximum daily demand per direction is around 100,000 passengers/d, or for a peak hour factor of 20% (as used for the rail proposals) this would be some 20,000 in both directions.

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

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

Phased Development of BRT

Phase 1 – 2018

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

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

Phase 2 – 2025

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

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

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

Phase 3 – 2035

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

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

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

Feeder Services

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

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

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

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

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

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

(4) Conventional Bus Network

Bus Network General Principles and Planning Framework

The public transport system for Greater Maputo to 2035 will include buses supporting mass transit (BRT and rail). The informal *chapa* industry will be progressively formalised until all informal *chapas* have been eliminated from the urban transport system, possibly by 2023.

High-capacity buses should be used wherever possible: with existing road conditions in Maputo the appropriate vehicle for the majority of routes will be a rigid single-decker approximately 12 metres in length with a capacity of 90–100 passengers; articulated buses may be operated on some routes. Infrastructure should be designed accordingly. Where operating conditions necessitate the use of smaller buses, such as in areas of low demand or where road conditions rule out the safe operation of large buses, it will be necessary to provide feeder services connecting with the trunk routes, but these should be the exception rather than the rule.

It is envisaged that the bus route network will consist of a series of radial routes converging on central Maputo, supplemented by peripheral routes providing direct links between points outside the city centre where required. On the major radial route corridors, where passenger volumes will be high, it will be necessary for road space to be reserved exclusively for buses, through the provision of segregated busways or bus lanes.

Bus routes will not terminate in Central Maputo, to avoid wasteful use of scarce and expensive city-centre land and to maximise the number of central area points served by each route. Normally this would be achieved by operating buses across the city centre, from one outer suburb to another, but the layout of Maputo, with coastlines on two sides, does not permit routes to cross the central area in a straight line, and therefore the options for through routing are limited.

There are two basic options: one, for routes to enter the central area, make a ninety-degree turn at some point, and leave the central area by a different route; the other is for each route to operate in a loop through the central area, and return by the same route. The latter approach avoids the need to ensure that the entry and exit routes are balanced in terms of passenger demand, and is the recommended one for Maputo. It is therefore proposed that each route should traverse the central area in one of a series of loops, to provide access to the maximum number of destinations, with minimum walking distance and without the need to change vehicles.

Even with bus priorities, delays will inevitably occur in the central area. To minimize the impact of such delays, which would create irregular frequencies on the return journey, it is recommended that alternate buses, after leaving the central area, terminate at a point just beyond the central area, where the layover time would allow for recovery from delays; on long routes additional intermediate terminals will be required to permit frequencies to taper away from the central area, and avoid the provision of wasteful excess capacity at the outer ends of the routes.

A conceptual route network has been designed for the central area comprising a series of loops covering the principal streets. Bus routes from outlying points enter the central area at six points. From each of these points, most routes will diverge to follow one of three loops through the central area to provide maximum coverage without the need to interchange.

Bus Routes through Central Maputo

A preliminary exercise has been undertaken to identify potential routes from the main corridors into the central area of Maputo, to illustrate some of the basic principles recommended for the future network. It should be recognised that these are conceptual proposals, and while they reflect the likely network requirements in broad terms, a detailed study must be carried out, with changes made where necessary, before any changes are implemented.

It is not recommended that there should be only one or two busways to be followed by all bus routes through the central area: this would give direct services to only those points within walking distance of the corridors. A denser network of routes is proposed, covering most main

roads within the central area. Routes entering the central area along the main corridors will fan out to follow different routes – some may converge again on leaving the central area and run out to other suburbs. City-centre terminals are not advocated. Some routes may require the buses to share road space with other traffic, but there will be a need for bus priorities, including bus lanes and possibly bus-only streets, along most if not all central area bus routes.

Most routes will enter the central area at points which are on the main corridors from outlying areas. The routes to be followed through the central area, by buses entering at each of the six points, are described below; it will be noted that there are three basic loops traversing the central area, and routes from all corridors will diverge so that buses will follow different loops.

1 Routes from Matola (via EN2) (and Catembe Bridge when it opens)

1.1 EN4 or Av de Mozambique – Av 24 de Julho – Av Julius Nyerere – Av Eduardo Mondlane - Av da Tanzania – Av 24 de Julho – EN2 (one direction only)

1.2 EN4 or Av de Mozambique – Av 25 de Septembro - Av Julius Nyerere – Av Mao Tse Tung – Av Marien Ngouabe – Av da Tanzania – Av 24 de Julho – EN2

1.3 EN4 or Av de Mozambique – Av 24 de Julho (Av Eduardo Mondlane in other direction) – Av Guerra Popular – Av 25 de Septembro – Av Vladimir Lenin – Av Marien Ngouabe – Av da Tanzania – Av 24 de Julho – EN2

2 Routes from Rua do Jardim and from Av de Mozambique

2.1 Rua do Jardim or Av de Mozambique – Av. Joaquim Chissano – Av Kenneth Kaunda - Av Julius Nyerere – Av Eduardo Mondlane (Av 24 de Julho in other direction) – Av Guerra Popular – Av Accordos de Lusaka – Av. Joaquim Chissano – Rua do Jardim or Av de Mozambique

2.2 Av de Mozambique – Av 24 de Julho – Av Julius Nyerere – Av Eduardo Mondlane - Av da Tanzania - Av 24 de Julho – Av de Mozambique (one direction only)

2.3 Av de Mozambique – Av 25 de Septembro – Av Julius Nyerere – Av Mao Tse Tung – Av Marien Ngouabe – Av da Tanzania – Av 24 de Julho – Av de Mozambique

2.4 Rua do Jardim or Av de Mozambique - Av. Joaquim Chissano – Av Vladimir Lenin - Av 25 de Septembro – Av Guerra Popular – Av Accordos de Lusaka – Av. Joaquim Chissano – Rua do Jardim or Av de Mozambique

3 Routes from Xipamanine and from Av de Angola

3.1 Av dos Irmaos Roby or Av de Angola – Av Marien Ngouabe – Av Mao Tse Tung – Av Julius Nyerere – Av 25 de Septembro - Av Guerra Popular – Av Eduardo Mondlane (Av 24 de Julho in other direction) – Av da Zambia – Av dos Irmaos Roby or Av de Angola

3.2 Av dos Irmaos Roby or Av de Angola – Av da Zambia – Av 24 de Julho – Av Julius Nyerere – Av Eduardo Mondlane – Av da Zambia – Av dos Irmaos Roby or Av de Angola (one direction only)

3.3 Av dos Irmaos Roby or Av de Angola – Av Marien Ngouabe – Av Vladimir Lenin - Av 25 de Septembro - Av Guerra Popular – Av Eduardo Mondlane (Av 24 de Julho in other direction) – Av da Zambia - Av dos Irmaos Roby or Av de Angola

4 Routes from Av Accordos de Lusaka

4.1 Av Accordos de Lusaka – Av Guerra Popular – Av 25 de Septembro – Av Vladimir Lenin – Av Marien Ngouabe – Av Accordos de Lusaka

4.2 Av Accordos de Lusaka – Av Guerra Popular – Av 24 de Julho – Av Julius Nyerere – Av Eduardo Mondlane – Av Tanzania – Av 24 Julho – Av Accordos de Lusaka (one direction only)

4.3 Av Accordos de Lusaka – Av Guerra Popular – Av 25 de Septembro – Av Julius Nyerere – Av Mao Tse Tung – Av Marien Ngouabe – Av Accordos de Lusaka

5 Routes from Av Vladimir Lenin

5.1 Av Vladimir Lenin – Av 25 de Septembro – Av Guerra Popular – Av 24 de Julho (Av Eduardo Mondlane in other direction) – Av Marien Ngouabe – Av Vladimir Lenin

5.2 Av Vladimir Lenin - Av Mao Tse Tung – Av Julius Nyerere – Av Eduardo Mondlane (Av 24 de Julho in other direction) – Av da Zambia – Av Marien Ngouabe – Av Vladimir Lenin

5.3 Av Vladimir Lenin – Av Kenneth Kaunda – Av Julius Nyerere – Av 25 de Septembro– Av Vladimir Lenin

6 Routes from Av Julius Nyerere

6.1 Av Julius Nyerere - Av Eduardo Mondlane – Av da Zambia – Av 24 de Julho – Av Julius Nyerere (one direction only)

6.2 Av Julius Nyerere - Av 25 de Septembro – Av Guerra Popular – Av Marien Ngouabe – Av Mao Tse Tung – Av Julius Nyerere

6.3 Av Julius Nyerere – Av 25 de Septembro – Av Vladimir Lenin – Av Kenneth Kaunda – Av Julius Nyerere

Some journeys at peak times on 1.2, 2.3, 3.1, 4.1, 5.1 and 6.2 may be diverted via Maputo Rail Station – Rue Marques de Pombal – Av Martires de Inhaminga - Av 10 de Novembro. Until the Catembe Bridge opens it will also be necessary for some buses to be diverted to serve the ferry terminal.

Within the central area, bus priorities (with-flow and contraflow bus lanes, dedicated busways, traffic signal priorities, etc), should be provided throughout the lengths of the proposed routes, as appropriate. Bus stops should be located at strategic locations along each route, at intervals of approximately 400-600 metres; wherever possible lay-bys should be provided at bus stops, including those in bus-only lanes, to permit buses and other traffic to overtake.

Buses on the northwest-southeast loop following Av Eduardo Mondlane and Av 24 de Julho will traverse the loop in one direction only, since the walking distance between them is short (approximately 300 metres) and for bus routing purposes the two roads may be considered as a single corridor. The loop should be traversed in an anticlockwise direction so that three turns out of the four will be left turns, to minimise conflicts between buses and other traffic. It is proposed that there should be a continuous segregated kerbside bus lane for the full length of the loop. This would commence at the intersection of Av 24 de Julho and Av da Tanzania at the western end, following Av 24 de Julho to its eastern extremity, then Av Julius Nyerere and Av Eduardo Mondlane to Av da Tanzania, which it would then follow back to the intersection with Av 24 de Julho. Since buses would traverse the loop in one direction only, parking (and loading/unloading) would need to be restricted on one side of the streets only. It may be possible to provide service roads between the bus lanes and the buildings to cater for vehicles loading/unloading. There should be exclusive bus lanes in both directions along Av 24 de Julho west of its intersection with Av da Tanzania: this may be either at the kerbside or in the central median.

Buses on all other loops would operate in both directions.

The possibility should be considered of making Av Vladimir Lenin (currently one-way from north to south along part of its length) a bus-only street between Av Mao Tse Tung and Av 25 de Septembro. Otherwise a contraflow bus lane should be provided on this street, unless it becomes two-way for all traffic.

The actual route network pattern may not be exactly as suggested, although it should be as close as possible: it will require more detailed study, and may be modified slightly in the light of proposals in the Master Plan for the road system, including traffic management and bus priority measures. The main requirement is that the route network should provide maximum coverage of the central area to minimize walking distances from bus stop to final destination, and to minimize the need for passengers to interchange.

F.5 Public Transport Infrastructure

F.5.1 Existing Situation

(1) Bus and Chapa Terminals

The main terminals in central Maputo used by TPM are Praca dos Trabalhadores, Museu, 25 Praca de Junho, Anjo Voador. All of these are on-street terminal points, with minimal facilities for passengers or bus crews, and are also used by *chapas*. At the outer ends of the routes buses turn and wait at roadside terminal points, again mostly with minimal facilities although shelters are provided at some.

Chapa terminals in Greater Maputo range from large busy terminals such as Museu and Anjo Voador in central Maputo, catering for a large number of routes, with several hundreds of departures daily, to roadside points serving only one route. The majority of terminals are on the public highway, or in the case of some smaller terminals, on vacant land adjacent to the highway. Facilities for passengers and crews are minimal.

There are a small number of purpose-built off-road terminals, such as that at Pl. Combatentes (also known as Xikelene); the terminal caters for both city *chapa* services, and intercity services to places such as Marracuene and Xai Xai. The operators' associations have asked for authority for international bus services to operate from this terminal, but this has not been granted. A new terminal, similar in design to that at Xikelene, is under construction at Zimpeto.

The design of the Xikelene and Zimpeto terminals is unsatisfactory for the safe and efficient operation of urban or long-distance bus services. There is excessive conflict between passenger and vehicle movements, and many buses must stop with their doors in the roadway instead of against the kerb, so that passengers must walk into the roadway in order to board. This is dangerous and causes obstruction and delay.

The terminal infrastructure, which is generally limited to the road itself, and passenger shelters at some locations, belongs to the municipalities.

(2) Bus and Chapa Stops

There are few designated en-route stopping places for buses and *chapas*. The latter in particular tend to stop at their own convenience regardless of safety or traffic conditions. There are a small number of passenger shelters, but these are in poor condition.

(3) Terminals for Long-Distance Bus and Chapa Services

Inter-city bus services from Maputo operate from terminals at Junta and Xikelene. There is a new terminal for international services in Baixa, adjacent to the Maputo City Transportation Traffic Bureau in Av. Albert Lithuli. Full-sized buses use the Junta terminal, but *chapas*, typically seating 15 to 20 passengers, operate from Xikelene and Baixa.

(4) Bus Depots

The only formal bus depot and workshop facilities functioning in Greater Maputo at present is the TPM depot in Maputo. TPM also has a facility in Matola but this has been out of use for several years; it is to be rehabilitated and will be used by the new Matola municipal bus company when the planned reorganisation of TPM is fully implemented. The Maputo facility includes parking accommodation for buses, but this is inadequate for the existing owned fleet of approximately 400 buses (including those which are unserviceable) and additional parking accommodation is provided by the Tata agent in Maputo.

There is workshop accommodation which would be adequate for an appropriately constituted fleet of up to 300 buses maintained under an effective preventive maintenance programme although some modernisation is required. It is inadequate for the present unsuitable and diversified fleet.

TPM also has its head office accommodation at the same site, where all management and supervisory staff are currently based.

(5) Ferry Terminals

There are three terminals used by the ferry services, at Baixa, Catembe and Inhaca. Improvements were carried out at the Maputo and Catembe jetties under the ProMaputo1 programme, but improved infrastructure is required at Inhaca. There are proposals by the ferry operator to further improve the infrastructure at the Maputo and Catembe terminals. Basic facilities are provided for the loading of vehicles and passengers at the cross-river ferry at Marracuene.

(6) Rail Stations

Greater Maputo is served by three rail lines, with 17 suburban stations, not including the main station in central Maputo: this is a fine building, maintained in excellent condition, with more than adequate capacity to cater for existing local and long-distance services. Part of the accommodation which is not required for use by the rail operator has been let out to private sector tenants who provide various retail and leisure facilities. Minimal facilities are provided at the suburban stations.

(7) Intermodal Facilities

Facilities for passenger transfer between various modes are limited. There is a bus stop at the entrance to the main rail station in Maputo, which provides convenient interchange for commuters using the rail service and is well used. However, passengers using the Catembe and Inhaca ferry services must walk distances of up to 500 metres from the terminal to access bus and *chapa* services.

Interchange facilities between local and long-distance services are also limited. Although some terminals, such as Junta and Xikelene, are served by both types of service so that transfer is relatively convenient, others such as the international *chapa* terminal in Baixa are not directly served.

The Airport is not served by public transport other than by taxis, although from experience in other African countries the existing level of activity at the airport would generate insufficient demand to justify the provision of regular public transport services. Nevertheless, there are proposals for a multimodal (bus, rail and air) interchange facility near to the terminal buildings.

(8) Roads and Pedestrian Facilities

Road conditions in Maputo are poor although improvements are being made under the ProMaputo programme. Some of the main roads are wide, straight and well surfaced and would be suitable for maximum sized buses, but at present some other roads are suitable only for smaller vehicles.

Traffic management and parking control is also generally poor, resulting in delays to all traffic including public transport. Congestion is already becoming severe at peaks, and as traffic volumes increase it will become a major issue which should be addressed before it becomes seriously detrimental to the provision of public transport services.

Pedestrian sidewalks generally are in very poor condition: in many cases surfaces are badly broken up and open drains are a common hazard. Piles of refuse and other obstructions including inappropriately placed street furniture impede the movement of pedestrians. These deficiencies affect access to public transport services, as well as pedestrian movement generally, and rehabilitation is urgently required. In addition, there are problems of lack of street lighting in some areas, with safety and security implications.

(9) Bus Priority Lanes

At present there are no traffic lanes reserved for buses in Greater Maputo.

F.5.2 Issues

(1) Bus Stops and Terminals

There is a requirement for formal, properly designed terminals to replace the generally inadequate facilities currently used. There are already proposals by the Maputo municipality for the construction or reconstruction of bus terminals at Benfica, Museu, Xipamanine, Magoanine, CMC, Laulane, Zimpeto, Junta, Missao Sao Roque and Baixa. A new terminal opened in 2011 at Kikelene. The majority of these terminals are for city services only, but those at Xikelene, Zimpeto Junta and Baixa are for longer-distance services. Work has already commenced at the Zimpeto terminal. The Matola municipality plans to build a new international bus terminal near the toll road.

There is also an ambitious plan for a multimodal interchange at the airport, providing connections between air, rail and road transport services, located where the rail line intersects the Acordos de Lusaka, a short distance from the airport terminal building.

Clearly there is a need for improved terminal facilities, but before any further commitment is made to new construction or reconstruction, it is recommended that there should be a pause to enable the requirements to be re-examined.

In the case of the terminals for urban services, the rationalisation of routes is likely to alter the requirement for terminals. For example, terminals are likely to be required to cater for a much higher proportion of full-sized buses, as opposed to *chapas*, than they do at present; the number of vehicles using some terminals may increase or decrease substantially; while it is possible that linking of routes may eliminate the need for central area terminals altogether. The

recommended route network study may also identify a requirement for terminals in areas where none are planned at present.

There may also be a case for some terminals to cater for both local and long-distance (including international) services, so that it is possible for passengers to transfer easily from one to another. The segregation of local and long-distance services at different terminals requires passengers to find their way from a long-distance to a local terminal or vice versa in order to complete their journeys, or alternatively make use of less efficient transport modes such as *txopelas*, taxis or private transport. This requirement has already been recognised in principle in the proposal for the multimodal terminal adjacent to the airport.

It will be necessary to review existing plans, as well as recently constructed and reconstructed terminals, to determine their suitability in the light of likely changes to the public transport route network in the future. It will also be necessary to develop a long-term plan for the development of terminals throughout Greater Maputo, identifying suitable locations and providing outline specifications including size and configuration. This should include the long-distance terminals, taking into account the need for convenient interchange between urban and long-distance services, and also the effect that the size, configuration and location of these terminals will have on the overall urban transport system.

The need for terminals in the central area will be minimised by routing buses across the central area, although some routes between Maputo and Matola may require small city centre terminals. Instead, the requirement will be for a large number of relatively small terminals throughout the Greater Maputo area outside the centres of Maputo and Matola. Most will be at the outer ends of bus routes, but some intermediate turning points will also be required, so that service frequencies can be tapered in tune with diminishing demand towards the outer ends of routes.

Terminals must be of adequate capacity, laid out to optimise the movement of buses and passengers, with minimal conflict between the two, and located in accordance with the requirements of the route network. The required size and configuration of each terminal will be determined by the projected number of buses passing through it, the sizes and basic configuration of the buses to be used, the number of different routes, the maximum number of buses standing or parked in the terminal at any time, and the number of passengers using it. Similarly, the locations will be determined by the route network and service frequencies.

These parameters will not be known until a detailed O-D study has been undertaken and the route network finalised. It is therefore impossible at this stage to identify specific locations for all bus terminals nor determine their size and configuration.

As a minimum requirement, all terminals should incorporate a surfaced area for buses to park between trips, passenger boarding bays for each route, shelters and facilities such as toilets, and basic office accommodation for supervisory staff.

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

Facilities required at stopping points along the route will depend on the number of passengers using them. At heavily used stops and points where passengers transfer between feeder and trunk routes, there should be adequate shelters for waiting passengers, and there may also be a requirement for lay-bys to allow buses to stop out of the main traffic stream. Smaller shelters may be provided at less busy stops, and some stops will require only a sign indicating the stop.

Private sector involvement in the provision of bus stop shelters, for example allowing them to be funded by the sale of advertising space, should be considered.

(2) Depots and Workshops

Bus depot and workshop facilities will be required for the formal bus fleet. The existing TPM depot and workshop in Maputo is poorly laid out and poorly located near the city centre, and ideally should be replaced.

In the long term the requirement will be for a number of depots, and these should be located towards the outer areas of Greater Maputo, in order to minimise "dead running" between the depot and routes at the beginning and end of each working day, and to use, as far as possible, available undeveloped and less expensive land. As a general rule, the most suitable size for an urban bus depot is one which can accommodate between 125 and 250 buses, occupying between approximately two and four hectares; it is likely that approximately ten depots will be required to cater for the needs of Greater Maputo within the next ten years.

They must be of adequate size and adequately equipped, and suitably located, typically nearer the outer ends of routes rather than near the city centre; as a general guide, the distance from the depot to the city centre should be at least approximately two thirds of the distance between the city centre and the boundary of the metropolitan area.

These facilities should ideally be provided by the operators themselves, although in view of the current level of development of the road transport industry, and limited financial resources of most businesses in the sector, it may be appropriate for the municipalities to construct them and rent or lease them to operators, on either a commercial or subsidised basis.

(3) Roads and Pedestrian Facilities

At present there are no traffic lanes reserved for buses in Greater Maputo, although if bus services are to operate with maximum effectiveness there should be priority measures to minimise delays caused by traffic congestion. On several of the main corridors there is ample space for bus-only lanes if roadside parking of cars could be restricted, and these restrictions effectively enforced. It would also be necessary to enforce the exclusivity of the bus lanes, and this would require a substantial improvement in the enforcement capability of the traffic police.

There is also potential on main route corridors for continuous bus lanes which are physically segregated from the rest of the roadway, to form the basis of a BRT system. Such lanes may be at the kerbside or in the centre of the road, but in either case would result in the displacement of considerable numbers of parked vehicles on streets in the central area. This in turn will require strict control of parking, and, unless the number of cars parking in central Maputo is to be restricted, will require the provision of off-street parking facilities – at a cost.

In addition to the benefits to passengers in the form of reduced journey times, increased bus operating speeds would enable buses to make more trips and would thus increase the capacity of the bus system, and reduce total operating costs.

Pedestrian access to public transport is impeded by the poor and often dangerous condition of many of the sidewalks. To maximise the quality of public transport services, this related issue must also be addressed.

(4) Intermodal Facilities

At present, virtually all urban passenger transport is by road, and there is only a limited requirement for interchange facilities. However, if alternative modes increase in significance, the requirement will increase.

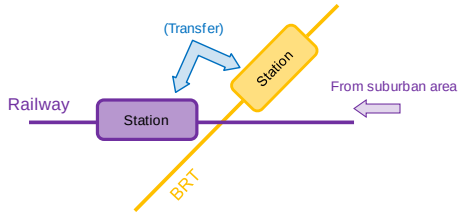
F.5.3 Options

(1) Intermodal Hubs

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

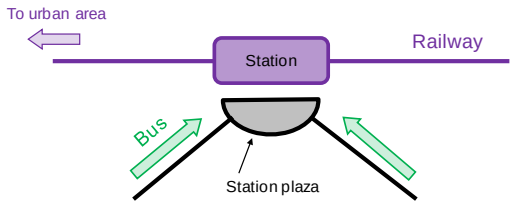
Stations in the urban area should be designed to provide for easy transfers to the BRT network (see Figure F.10). Better connectivity to other public transport modes will result in higher efficiency of the urban transport system as a whole. For that purpose stations should be located near intersections with the BRT network and station entrance/exit gates should be placed near the BRT station.

The primary concern for suburban stations is transfers to/from the bus/chapa network (see Figure F.11). Buses/chapas collect passengers in surrounding residential areas and deliver them to the station. Stations therefore should be located at places where access roads are secured. A bus terminal plaza should be prepared at each station to make transfers easy. Taxi ranks located at these interchange also help maximise integration and accessibility.



Source: JICA Project Team

Figure F.10: Intermodal Facility in Urban Area



Source: JICA Project Team

Figure F.11: Intermodal Facility in Suburban Area

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

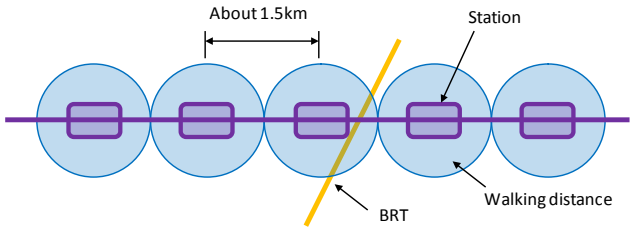
These allow passengers in the city centre to take the first arriving trunk unit without waiting for a specific route number, which reduces waiting times and queues. The waiting/station areas needed on the central area trunk sections are therefore relatively small.

(2) Rail Stations

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

Central/Urbanized Areas: Stations in central/urbanized areas are direct access points for neighboring business and commercial facilities and also function as transfer points for other

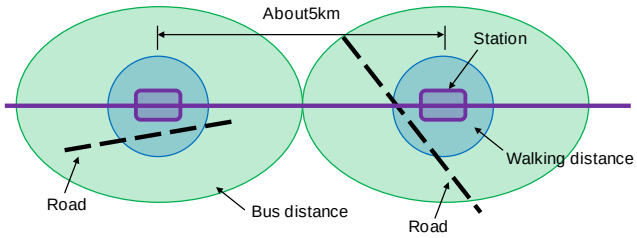
public transport modes. Stations in these areas are therefore placed at intervals of about 1.5 km and at junctions with other public transport modes (Figure F.12).



Source: JICA Project Team

Figure F.12: Station Location in Central/UrbanizedAreas

Suburban Areas: Stations in suburban areas are primarily points from where commuters in the surrounding residential areas are transported to the urban center. Residents of surrounding areas reach the station on foot (or by chapa at present). Therefore, stations are placed at intervals of about 5 km and at locations where access roads can be secured (Figure F.13).



Source: JICA Project Team

Figure F.13: Station Location in Suburban Areas

Station and Station Plazas: At-grade stations are considered to minimize costs. Footpath overpassses for passengers to cross tracks would be included. In suburban areas, station plazas (providing bus services in front of the station) would be developed to facilitate intermodal transfers (Figure F.14).

Source: JICA Project Team

Figure F.14: Concept of Station Plazas

(3) BRT Terminals/Interchanges

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

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

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

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

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

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

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

(4) Conventional Bus Stops and Terminals

Two basic options are for the present plans and proposals for the redevelopment and construction of terminals to proceed, or to review these plans in the light of likely changes to the route network and industry structure resulting from implementation of the Master Plan recommendations. In view of the likely changes, there is a risk that many of the new terminals currently planned would be inappropriate in terms of their location, size and configuration.

With regard to en-route bus stops, there is a requirement for formal designated stopping places on all routes, and for these to be effectively enforced: the alternative is to allow the present

unsatisfactory situation to continue. Ideally, suitably designed passenger shelters and bus lay-bys should be provided where these are required.

It is common practice internationally for passenger shelters at bus stops to be provided in partnership with the private sector, with the latter constructing and maintaining the shelters at their own expense, in return for the right to sell advertising space on the shelters. This is a funding option to be considered for Greater Maputo.

(5) Depots and Workshops

The proposed formal bus industry will require formal off-street facilities for overnight parking, servicing and maintenance of buses in order for the operators to function.

Two key options are whether or not to replace the existing TPM depot with one in a more suitable location, and alternative locations for the additional facilities which will be required. As discussed, all depots should be located towards the periphery of the urban area.

The present TPM depot is located in a residential area and is too close to the city centre for efficient operation, although as long as it is the only depot it is reasonably accessible to all routes. While it should eventually be replaced, this should be deferred until at least two other new depots have been constructed. Sale of the existing site, which should be of relatively high value, should help to fund the new depot developments.

There is also the option of ownership of the depots. In a developed country it is normal for depots to be owned by the transport operators, but the investment is considerable, and likely to be unaffordable by potential new bus operators in Maputo. In any case, if bus routes are to be licensed to operators under fixed-term contract arrangements for ten years or shorter, they may be unwilling to make long-term infrastructure commitments.

The alternative is for the public sector to fund the construction of the terminals, and to lease them to bus operators on a short-term commercial basis. This option has the advantage that a single depot may be leased to several small operators. This is likely to be an essential requirement, particularly during the initial stages of the process of formalising the road transport industry.

(6) Complementary Measures

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

Improvements to roads and pedestrian facilities are easy to justify but there may be funding constraints. The options are therefore concerned with prioritising the competing potential projects. From a public transport perspective, general improvement to the basic road and sidewalk infrastructure should be given high priority, together with bus priority measures where these are required.

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

F.5.4 Recommendations

(1) Railway Equipment and Facilities

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

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

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

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

Option A: Feature: Current trains and new passenger trains will share the same tracks (Figure F.15)

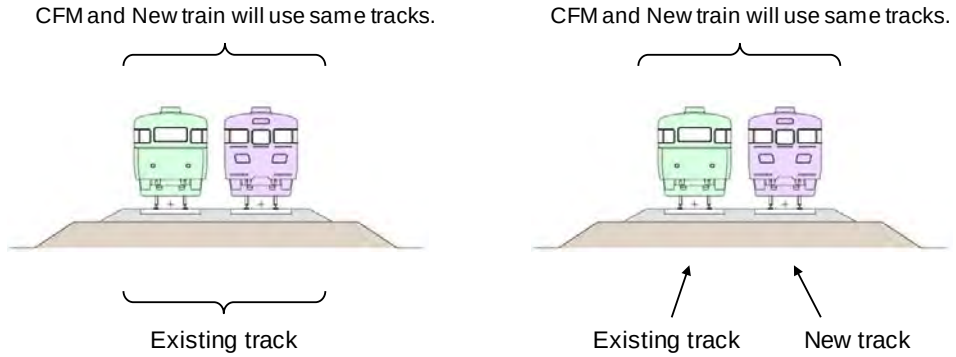
Merit: The cost of civil construction work is minimal.

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

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

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

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



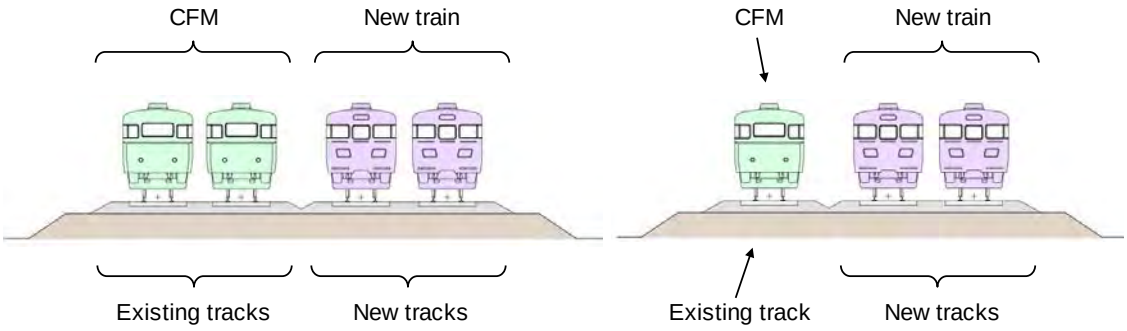
Source: JICA Project Team

Figure F.15: Option A for Track Construction

Option B: Feature: New double track lines for the new services will be constructed, leaving the existing CFM services intact (Figure F.16).

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

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



Source: JICA Project Team

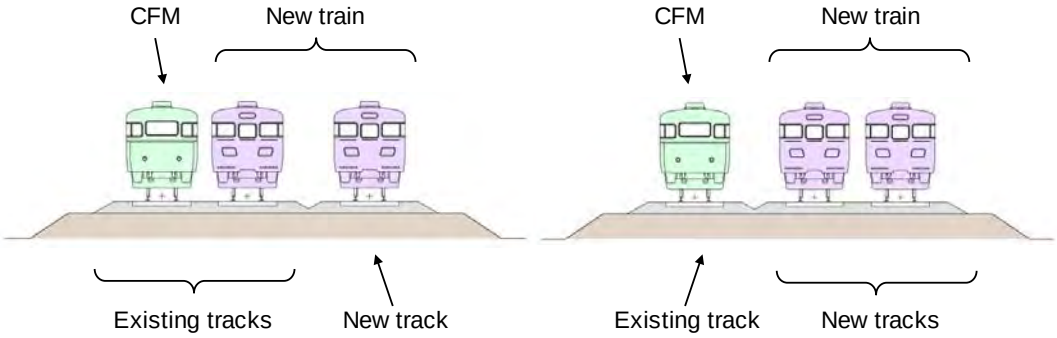
Figure F.16: Option B for Track Construction

Option B-1: Feature: Current trains will use single track and new tracks will be constructed where necessary to provide double track for the new passenger services (Figure F.17).

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

Measure: Rescheduling of existing CFM services.

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



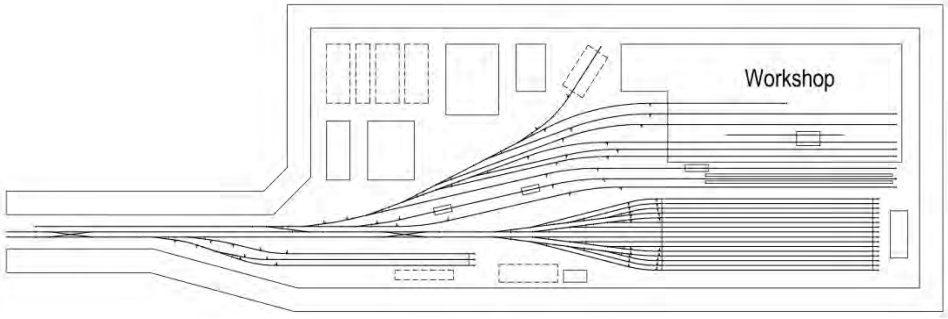
Source: JICA Project Team

Figure F.17: Option B-1 for Track Construction

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

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

Train depot(s) (Figure F.18) and a workshop will be constructed. One depot for the whole network is desirable. If not possible, multiple locations for depots may be necessary. The depot(s) will require 15–20 ha.



Source: JICA Project Team

Figure F.18: Concept of a Depot

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

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

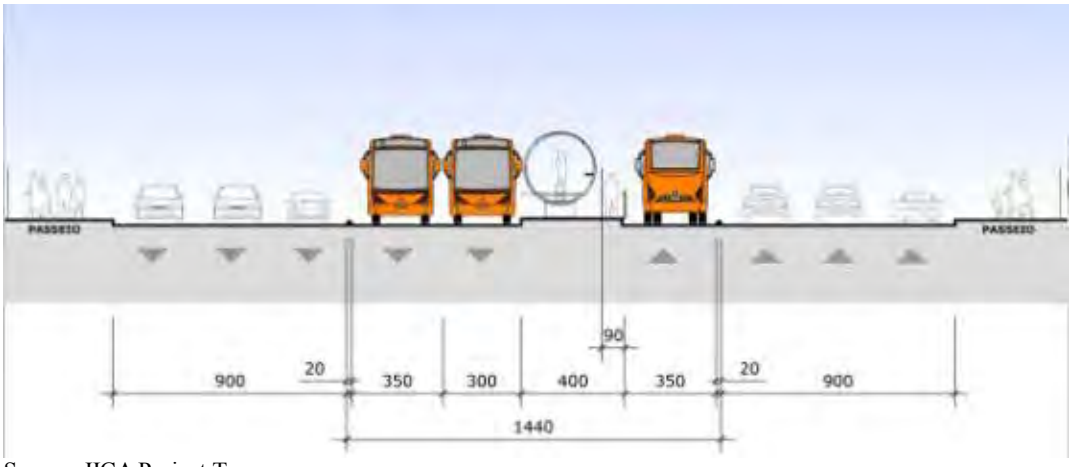
(2) Specification of the Phase 1 BRT Corridors

Pilot project: Maguanine/Xiquelene/Praça dos Herois and the Baixa.

The design of the most heavily used BRT routes should thus incorporate overtaking at stations, which implies a design width of 38 m for traffic with 3 lanes and including a sidewalk of 2.5 m on each side. A diagram of a typical cross-section with a busway flanked by the traffic lanes is shown in Figure F.19.

For two-lane traffic flow this minimum width would be reduced to 33 m. Note that passenger access is allowed behind stations; if a station is handling BRT in both directions, this width would be reduced to 32 m.

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



Source: JICA Project Team

Figure F.19: Cross Section of Station Area with Overtaking Lane and Three Urban Traffic Lanes

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

Central access stations are now generally adopted as they require less road width and are cheaper to install, operate, and maintain. Dimensions vary, but a minimum width of 3 m is often used. Typically articulated BRT units have 3 or 4 doors of 1.20 m minimum and access from stations is at floor level and by the central door.

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

Key specifications follow:

- The busway is projected to be in reinforced concrete with an adequate road base. Although the exact specification will depend on each stretch, most of the busways and overtaking lanes will be on a geological base of alluvial sands.
- These lanes will be separated from other traffic by studs in resin 10-14cm in height that allow the bus units to exit the lanes while avoiding encroachment of the busways by other traffic.
- The roadways will have basic landscaping and tree planting as part of general urban improvements.
- Stations are to be set at every 400–500m, with sliding doors for at-floor bus access and an internal cooling system based on the flow of cooled air. Security will be needed, provided by security personnel and communications systems. The projected door width is 3m.
- The expected number of stations is about 30, including 25 stations that offer access to busways in both directions, and stations that, for reasons of width, only provide access to one direction of busway. At the Baixa there will be full integration with the main rail station.
- Fares will be collected from smartcards with readers at the stations. An estimated four readers and turnstiles per station will be required, with 150,000 cards issued. Initially integration will be within the BRT system, covering the main routes and all feeder and Inter District routes. Eventually, the cards could also be used for rail travel.
- Intelligent transport system (ITS) measures will include green light priority for BRT (with extension and early cutoff for other stages). Pedestrians will also use signals where appropriate so as to allow for special-needs access. The system will have a control centre and standard GPS unit control.
- Pedestrian access to the station areas will be improved along the corridor 250m on each side of the stations and on both sides of the corridor (a total of 25km).
- Extensive feeder bus route improvements will be considered, e.g., improved stops, paving.
- As well as the main terminal facilities at Maguanine and Baixa, the system will have a basic BRT depot that will be completed and operated by the concession holder, and integration platforms and works at Praça dos Herois and Xiquelene.
- Most of the road widening and resettlement will be concentrated in the stretch between Xiqueleneand Maguanine, while drainage works will be concentrated in the section on Acordos de Lusaka.

N1 BRT Services: Alternative Route Using the Part of the Pilot Project Busway

In order to offer BRT quality public transport to the communities along the N1 at a cost which is affordable to the city and users, it is essential to minimize the bottlenecks along the N1 (short-term traffic management interventions and use of one-way systems) and reduce the travel times in the congested central areas. At the same time, it is necessary to guarantee that the BRT busway proposed for Acordos de Lusaka and Guerra Popular will be fully used.

The proposed alternative for N1 services addresses both these issues by slightly modifying the existing road system and adding a short busway link on the existing rail RoW. Thus, instead of implementing a busway on the severely constrained section of the N1 between Bagamoio and Jardim/ Av. OAU, it is suggested to add an extension of the Pilot Scheme BRT busway that links the initial BRT corridor of Av. Acordos de Lusaka to the N1 with an interchange at or near the Praça dos Heróis. From this point (and terminal facilities) the busway follows the N1 corridor up to the intersection with Maria de Lourdes Mutola.

Source: JICA Project Team

Figure F.20: N1 to Praça dos Heróis Link

Section 1: Baixa – Praça dos Heróis 4.7 km; Museu – Praça dos Heróis

This section is comprised of the proposed busways to Baixa and Museu. As the specifications allow for overtaking on the most loaded stretch, no major capacity restrictions should be encountered. As the demand splits evenly between both downtown destination, these final city centre stretches are conceived to be operated without overtaking.

Section 2: Praça dos Heróis – The Railway 0.6 km

The busway section from this interchange follows the central median of Av. Acordos de Lusaka to the railway overpass. Before this structure the busway uses a grade separated access to enter into the southern part of the rail RoW.

Source: JICA Project Team

Figure F.21: Ramp Access from Acordos de Lusaka to the Rail RoW

Section 3: Rail RoW – Av. Angola 0.4 km

The 7m busway follows the southern RoW to Av. Angola, where at this junction (signals) it meets the proposed GagoCoutinho binary.

Section 4: GagoCoutinho Binary 0.9 km

This binary makes use of the parallel road system running next to the airport to increase capacity and allow for the retro-fitting of the BRT busway. A simple at-grade junction at the western end of this 900 m section (signals) allows returning flows and E-W continuity.

Source: JICA Project Team

Figure F.22: GagoCoutinho Binary

Section 5: Airport Perimeter Road West 1.5 km

The busway then follows the road next to the western perimeter of the airport for 1500m, requiring at-grade widening of this road to include the 7 m busway. For nearly all of this section the RoW is some 30 m, permitting two lanes southbound, a 7 m busway and two lanes northbound, with a 1 m separator and 3.5 m sidewalks. Stations will require space for overtaking lanes. At the junction with Av. Mozambique is the major Integration Terminal Zoo (Zoologico).

Source: JICA Project Team

Figure F.23: Zoo Terminal Area

These sections would have stations placed at about 600m intervals along the 3.3 km stretch as shown in Figure F.24 and Figure F.25.

Source: JICA Project Team

Figure F.24: Stations on the Zoo–Av. Angola Section

Source: JICA Project Team

Figure F.25: Stations on the Av. Angola–Praça dos Heróis Section

Section 6: Terminals Zoo – Airport North 0.9 km

The Airport North Terminal will serve to pick up demand from the districts to the north not served by the Choupal Terminal and also feeder routes coming from Rua da Paz. Road widening can be carried out by setting back the airport fence by 5 m.

Section 7: Airport North - N1 Terminal 4.2 km

This is the most complex section of the BRT busway as widening will involve some resettlement and drainage management as well as a modification in the traffic management in order to gain access to the terminal areas.

This section is envisaged as an Express busway with stops only at the Terminal areas. This is a common form of operation in Latin America and allows for two construction alternatives:

a) Road widening to include a 7 m busway – no overtaking and station widths necessary;
b) Building the busway as a 7 m overhead structure with ramps to and from the terminal areas.

Option b) is more expensive; however, this does guarantee that the busway will be free from the congested highway and chapa and passengers queues. Concentrating passengers at the terminal stations also minimizes the risks of pedestrians crossing the highway and offers better integration and space for facilities such as safe bike parking.

Option a) has been adopted for costing and includes the Terminal and Integration Stations of :

- Maria de Lourdes Mutola (N1)
- Benfica
- Choupal
- Airport North
- Zoo

Source: JICA Project Team

Figure F.26: Section 7 Station and Terminal Areas

BRT is an extremely flexible mode and according to the analysis carried out during the PFS this BRT Route could be, for example, from the Terminal N1 area to the Museu – a W-E orientation to counterpoise the Magoanine-Baixa Route operating from N-S.

The interchange facility at Praça de Heróis would allow for transfers between routes and avoid the need for both corridors to offer both the Baixa and Museu as route options - which implies 4 trunk routes (two destinations and two route types: stopping and express servcies), leading to greater headways and possible station bay and passenger overloading problems.

Additional feeder bus services – either operated by the BRT company or contracted to adequate chapa services or yet again, operated in a non-integrated fashion by the existing chapas – would use the Terminal areas.

In all these options, the access to the Terminal area to and from the N1 highway and BRT lanes would be made at-grade and with signals.

(3) BRT Terminals

The proposed BRT Integrated system will be formed by linking the following major Integration Hubs:

Table F.4: BRT Terminal Recommendations

Terminals	Terminal Characteristics
Estação CFM	Main Integration area for all suburban rail and the BRT routes coming from Matola, Katembe and the North
Maguanine	First major terminal for feeder units and starting point of the First Trunk Route
Xiquelene Adaptation	The existing bus station will need to be adapted to serve as a 'through' terminal with a design that minimizes the loss of time of the main trunk BRT routes. Access for all units as well as feeder units and passengers will also need to be reviewed.
Praça dos Herois	It is expected that there will be pressure to integrate services from Av. Moçambique to the BRT routes that will require facilities to be incorporated into the initial designs. Provision for this should be made in the initial phasing.
Matola	As well as receiving the feeder routes from Matola, this terminal will also serve Boane and will be dimensioned as such
Jamo	This terminal is essential to structure the N4 urban corridor and will serve the new areas in the immediate region, as well as the commercial installations along the corridor
Matola City	Already an important chapa terminal as well as suburban train station, this terminal offers integration between all services, especially the InterTerminal services envisaged that will link the main corridors
Zimpeto	An important chapa terminal, this terminal serves Zimpeto Market as well as the stadium. It also offers integration between all services, especially the Inter Terminal services
Albazine1	These stations will integrate the expanded BRT and rail networks to cover the demands from these rapidly developing areas
Albazine2	These stations will integrate the expanded BRT and rail networks to cover the demands from these rapidly developing areas
Katembe	In order to operate a simplified form of BRT - with priority on the bridge and access roads - terminal facilities will be needed. These will have feeder bus and park and ride as the tolls and congestion levels will aid in promoting modal transfer from the private vehicle to BRT

Source: JICA Project Team

(4) Bus terminals

Present plans for terminal redevelopment and construction should be put on hold, and a comprehensive study, based on future route network and service requirements and proposed changes to the bus industry structure, should be undertaken to determine future requirements and develop a plan for implementation.

(5) Bus Stops

As part of the recommended route network study, locations for designated bus stops will be identified for all routes. Suitable signage should be provided at all stops. Where necessary due to traffic conditions, bus lay-bys should be incorporated into the road design. Passenger shelters should be constructed at stops to be identified, and should be funded through a PPP arrangement.

(6) Bus Depots and Workshops

It is recommended that a study should be undertaken to determine the number, size and location of depots required for the future service network and bus fleet. When two or three of the new depots become operational, the existing TPM depot in Maputo should be demolished, and the land sold; proceeds from the sale should contribute towards the funding of the new facilities.

(7) Roads

The backlog of road maintenance on bus routes should be given high priority, together with the provision of bus priority measures where required.

(8) Pedestrian Facilities

Priority should also be given to improving the condition of pedestrian sidewalks, including the removal of rubbish, relocation of street furniture causing obstructions, and prevention of parking of vehicles on sidewalks.

F.6 Public Transport Fare Levels and Structures

F.6.1 Existing Situation

Fares charged for public transport services must be approved by Government. The municipalities are nominally responsible for regulating fares. In practice they have normally been determined by the Ministry of Transport and Communications in order to ensure that fares are consistent between the different municipalities. However, the most recent fares increase, in November 2012, was only applied to services in Maputo and Matola; fares in Marracuene and Boane were not increased until February 2012.

Until November 2012, *chapa* fares varied from MT5 (MT3 before 2008) for journeys up to 15 km to MT 7.50 for up to 30 km. From November 2012 fares were increased to MT 7 for distances up to 10 km, and MT 9 for longer distances.

In practice, *chapa* passengers pay much higher fares than those stated. In order to increase their revenue, many *chapa* drivers have adopted the practice of "route cutting", i.e. cutting routes into short sections so that passengers must transfer to another vehicle, and pay an additional fare (or several additional fares), to complete their journeys. This enables each *chapa* to operate more trips, carry more passengers and earn more revenue per day. Therefore, many passengers pay much higher total fares for their journeys than is intended by the government in setting the rates. Although operators were asked to desist from route cutting when the fares were increased in 2012, they nevertheless continue to do so.

Due to route-cutting a journey which should cost MT 7.50 may cost MT 15, or one which should cost MT 9 may cost MT 15 or MT 22.50. For some long journeys even higher fares are paid. A large proportion of passengers are affected by this practice.

Fares charged by TPM on its formal bus services are generally lower than those charged by *chapa* operators in order to provide affordable transport for those on low incomes. However, this social benefit is not available to everybody, due to TPM's limited service. This is regarded as a social obligation due to TPM's public-sector status.

Fares currently charged by TPM for journeys within the city of Maputo are MT 7.00 for a normal service (MT 9.50 on some longer routes). Fares for normal services to points outside Maputo are MT 12.00, although passengers travelling short distances on these routes are charged MT 7.00. MT 20.00 is charged on "express" services (which stop only at the major bus stops) to points outside Maputo. There are discounted weekly and monthly tickets for students, at MT 30.00 per week or MT 90.00 per month for journeys within Maputo and MT 66.00 per week or MT 132.00 per month for longer journeys. There are also concessions for veterans, who are charged 50% of the normal fare. These concessions are not available on *chapa* services.

Fares charges on buses operated by the private sector are similar to those charged for *chapas*.

Rail fares are charged by route section, regardless of distance within the section: all local journeys within the Greater Maputo area on urban trains, or in third class on normal trains, cost MT 5.

The fares charged on the Catembe ferry have not been increased since 2003 although costs have increased substantially; passengers are charged MT 5.

Taxi fares are set by the operators' association in liaison with the municipality, and are currently MT 50 per km. In practice, they are flexible and subject to negotiation, but meters are to be fitted to all taxis to ensure that the correct fares are charged; some are already fitted. Meters should have been made compulsory for all taxis by January 2012 but this has not yet been achieved.

Fares charged for *txopelas* are typically MT 35 per km but are subject to negotiation and there are no set fares.

(1) Fare Collection and Ticketing Systems

Chapa fares are collected by informal conductors, normally employed by the driver; no tickets are issued. Paper tickets are issued on some private sector buses. Since the driver is responsible for paying for fuel and other basic operating costs out of the revenue collected, it is ultimately his responsibility to ensure that the conductor collects all fares. The *chapa* owner has no interest in the revenue collected provided that the driver pays the charge for the vehicle.

According to FEMATRO there are plans, initiated by government, to implement an electronic ticketing system in Maputo. A company has been formed to purchase the ticket reading machines (funded by FTC); approximately MT 2.5 of each fare will go to this company to pay for the machines and tickets. The ticket reader will detect how many journeys the passenger has made in a day; the first two journeys will be at a discounted rate, but subsequent trips will be deemed unnecessary and charged at a higher rate. The justification is that only essential trips should receive the full subsidy.

Ticket machines will not be compulsory on buses and *chapas*, and illegal *chapas* will not be eligible; however, passengers using vehicles without machines will not receive a discount. The benefit to passengers of the MT 2.5 payment towards the cost of the electronic ticketing system is not clear. This system has not yet been implemented.

TPM fares are collected by conductors, who must pay in all revenue at the end of each shift: crews are paid salaries in the conventional manner, unlike the *chapa* crews. Revenue integrity is a problem; tickets are issued and inspectors are employed to make random checks but there is thought to be substantial leakage. Some buses are equipped with electronic ticket issuing machines and there are plans to extend these eventually to all buses. Inspection will be made easier because more information will be printed on the tickets, and the system will facilitate the introduction of a more complex graduated fare structure: this is not planned at present but may be considered in future. It would also eventually eliminate the need for conductors, some of whom could be retrained as drivers.

(2) Subsidies

Although it is government policy not to subsidise bus operators, it currently offers subsidies in two forms, to public and private sector operators respectively. To enable the public sector companies to charge low fares, and also to make good losses incurred due to their inefficiency, the government pays them substantial operating subsidies as well as assisting through the purchase of new buses. TPM's operating subsidy is currently equivalent to approximately 50% of its total expenditure.

Approximately 80% of CFM's costs are covered by subsidy and only 20% from freight and passenger revenue. Passenger services are operated to meet social obligations, at very low fares. Most revenue comes from freight, which is the main activity.

The Catembe ferry service also loses money but receives financial support from government.

In the case of the private sector operators providing urban services, the government offers a subsidy in the form of a rebate on fuel tax to reduce the fuel price to MT 31per litre. Only fully licensed operators may claim the rebate; others cannot do so. Operators claim that the subsidy is insufficient to compensate fully for the shortfall between costs and revenue at approved fare levels, even after the most recent increase.

F.6.2 Issues

Public transport fares are an important and sensitive issue which must be appropriately addressed especially when there is to be any substantial improvement in services.

(1) Fare Levels and Affordability

The level of public transport fares in Greater Maputo is a major issue and has a significant impact on the extent and quality of the services provided. Operating costs have been steadily rising in recent years, while operators' net incomes have been declining. There have been periodic increases in fares but these have not fully compensated for the cost increases. Transport operators consider the fares to be low, while some users feel that they are excessive.

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

argued that an immediate aim should be to cater for existing requirements as effectively as possible, at fare levels similar to those currently being paid, while at the same time covering all costs of providing the service.

Two key factors are that due to the practice of route-cutting, many passengers are paying fares for their journeys which are higher than those intended by the authorities when setting fare levels. While passengers may resent this, they are nevertheless paying, and are able to do so. This should be recognised. The second is that the efficiency of the present service is low, due largely to poor utilisation resulting from inefficient operating practices and traffic congestion. Improvements in efficiency will reduce costs, and reduce, if not eliminate, the current imbalance between costs and revenue. It must also be remembered that the quality of the present service is low; this can and must be improved, but the extent to which it is improved will affect the cost, and a balance must therefore be found.

(2) Frequency of Fare Adjustments

Approval for operators to increase fares is given infrequently; the last three approvals were in 2004, 2008 and 2012, i.e. at four-year intervals. As a result, when increases are authorised, the extent of the increase is necessarily substantial. In 2008, there were violent protests against the increases of up to 67%, which came as a shock to people whose incomes are low. If fares had been permitted to increase more frequently but by smaller increments as is the case with the majority of goods and services, the effect would have been less noticeable and controversial.

(3) Cost Recovery

According to bus and *chapa* operators, current fare levels are inadequate to cover the full cost of providing the services, even after the most recent fares increase. TPM receives a subsidy to make good its losses while private sector operators are compensated with a subsidy on diesel fuel to keep the cost at MT 31 per litre, but this is inadequate to cover the full shortfall between costs and revenue. Many *chapa* owners have gone bankrupt or left the industry as a result of poor financial performance. Very often, people buy *chapas* but after operating them for a time they realize that they are losing money and sell them on: the new owners then go through the same cycle. Some operators have transferred to operating their *chapas* for school transport which is more profitable.

It is essential that public transport fare levels are adequate to cover all costs of providing the services, unless any shortfall is compensated for by some form of subsidy. However, it is difficult to determine what this level should be. At present, the operations of both the formal and informal public transport sectors are inefficient. TPM suffers from very low vehicle availability, so that its fixed costs must be spread over approximately 25% of the kilometres which should be operated. In the case of the *chapas*, the informal scheduling procedures (which reduces revenue) and poor condition of the vehicles (which increases costs) are primary causes of the poor financial performance of the sector.

It would be unreasonable for fares to be set at a level which paid for such inefficiencies. Nevertheless, in future there should be a means of determining what would be an adequate level of fare for a service operated to a reasonable standard of efficiency, and to ensure that operators are permitted to charge accordingly.

If government decides that fares should be below this level, then operators should be fully compensated by subsidy. The required level of efficiency would be achieved through changes in the nature of the public transport industry, and in its regulation, as discussed elsewhere.

(4) Subsidy

Official government policy is that public transport services should be operated commercially, without subsidy. There is a general understanding, however, that services should be provided at "social" fares, and fare levels are controlled by government with this objective. This creates problems if fares are controlled at levels which are insufficient to cover the cost of service provision.

TPM currently provides services at fares lower than those charged by the private sector in order to assist those with low incomes. The resulting shortfall between operating cost and revenue is compensated for through a government subsidy (in contravention of policy). Since February 2008 urban *chapa* operators have been offered a partial rebate on fuel duty (again, in contravention of policy) as a means of assisting them with the high cost of fuel. However, private sector operators who are not adequately subsidised through the fuel rebate are unable to cover their costs at the approved fares and resort to undesirable practices in order to survive.

At present TPM's service is limited due to a shortage of vehicles. However, if the level of operation is expanded significantly, and if all are operated at the current fares, not only will many higher-income passengers benefit unnecessarily, but the requirement for subsidy will increase substantially. Government must decide whether this is acceptable; if not, the increase in TPM's operation, while desirable, would not be financially sustainable.

As mentioned above, given the level of demand for public transport in Maputo, it is likely that most if not all public transport services in the city could cover their costs at fares not substantially higher than those charged at present, without the need for subsidy, if they were operated efficiently, with the appropriate vehicles, as part of a well planned and regulated system.

(5) Fare Structure

As well as the fare level in quantitative terms, the characteristics of the fare structure are also important. The basic alternatives are for a single flat rate fare to be charged, irrespective of the distance travelled, or a fare which varies according to the distance travelled. In the latter case, a route is typically divided into sections, or "fare stages", with the fare for a journey increasing according to the number of fare stages covered. Options range from a very "course" fare scale, with relatively few, long fare stages, and fares increasing by large increments at each stage, to a very "fine" scale, with short fare stages and small increments. In general terms, the coarser the scale the easier it is to control revenue (in particular, preventing passengers from "over-riding", or travelling longer distances than they have paid for), and for practical operational reasons it is desirable for fare stages to be longer rather than shorter.

In Maputo, the fare scale is extremely course. *Chapa* fares currently vary from MT 7.5 for journeys up to 10 km to MT 9 for longer journeys. TPM applies a flat fare of MT 7 on most of its routes, with higher flat fares on some longer routes and express services.

A flat fare, or a course fare scale, may be considered inequitable, since short-distance passengers must pay a higher rate per km than those travelling longer distances, despite incurring higher costs. From the operators' viewpoint, revenue per km for longer routes is lower than for short routes, making the former less profitable, and encouraging practices such as route-cutting.

A fare structure in which fares were more closely related to the distance travelled would reduce these problems, and make many unprofitable routes profitable. However, a more complex fare structure would also require a more complex fare collection and ticketing system, which would

be difficult to implement, particularly for informal services. Nevertheless, if any substantial improvement in services is to be achieved, the problem must be addressed, and in the longer term a form of electronic ticketing should be adopted for all public transport modes, on a system-wide basis, throughout Greater Maputo in order to make it possible.

If the costs of operation and numbers of passengers to be carried are known, it is easy to calculate the average fare required. However, unless one "flat" fare is charged regardless of distance, the fare structure must be carefully designed to ensure that the required average is achieved so that total revenue is adequate. This is a complex modeling task, requiring detailed information on passenger travel patterns (and assumptions regarding the effect of changes in the fare structure on those patterns) and in practice has a substantial element of "trial and error", requiring several fares adjustments before the most appropriate structure/rate combination is found.

(6) Revenue Integrity

Public transport is susceptible to revenue leakage in various forms, due principally to the fact that vehicle crews are to a large extent unsupervised and usually handle large quantities of cash. Revenue leakage has contributed to the failure of many conventional bus systems, while at best, if an operator is lax in minimising revenue loss fares will be higher than would otherwise be necessary, profits lower, and the service poorer.

Revenue may be lost through fare evasion on the part of passengers and through malpractices on the part of the operator's own employees; there may also be collusion between passengers and employees to defraud the operator. Passengers may attempt to avoid payment altogether, or pay less than the correct charge for the journey taken. Passengers may travel without paying, by evading the conductor if there is one, or, where buses are one-person-operated, by boarding the bus through the exit door to avoid paying the driver; if passengers are required to purchase tickets from automatic vending machines, they may by-pass the system and travel without tickets.

Revenue integrity is partly a function of the degree of honesty prevailing at all levels in the organisation, as well as the effectiveness of revenue control systems; the extent to which the revenue leakage problem can be resolved will have a bearing on type of service which can be provided, and on methods of operation. Good revenue integrity will enable a much more organised type of service to be provided, while poor revenue integrity necessitates a less formal type of operation. Robust systems and procedures are required if revenue is to be adequately protected.

Except where a flat fare system applies, a common form of evasion is over-riding, or travelling farther than the distance paid for. Detection depends on vigilance by the conductor or by random checks by revenue inspectors; over-riding can be very difficult to control if fares are collected by the driver or by a seated conductor.

However, the most serious problem is usually pilferage by employees, principally those directly responsible for collecting fares, namely the conductors and drivers, but also those in supervisory positions such as revenue inspectors who may be in collusion with crews. Cash handled daily by a conductor may be several times his monthly salary: the temptation to steal is therefore great. Non-issue of tickets, issue of undervalued tickets, and re-issue of tickets, are all common offences committed by conductors. There may be collusion between conductors and passengers; typically, a dishonest conductor will charge the passenger less than the correct fare, and issue a ticket for an amount less than the amount actually paid, so that both parties benefit at the operator's expense. Crews often also defraud passengers by overcharging or giving short change.

As well as revenue loss through dishonesty, there may be loss through crew ineffectiveness, or inefficient fare collection systems, resulting in failure to collect all fares.

Revenue leakage is less of a problem in the informal sector, where crews' incomes are directly derived from the revenue they collect: the only scope for pilferage is for the conductor to fail to give all money collected to the driver, or to defraud passengers. This is one reason why the informal sector can survive when often a formal operator cannot.

(7) Ticketing

Most revenue control systems are based on the use of tickets as proof of payment for a particular journey. A ticketing system is usually also a valuable source of management information, providing data on passenger loadings by route and journey, for both accounting and planning purposes. The system should be secure, in that tickets cannot easily be forged, altered or re-used.

Some systems are more effective than others in terms of security and data generated; in general terms, the more effective the system, the greater its complexity, and the more expensive it is to install and maintain.

The ticketing system should be convenient to use, and should minimise the time and effort required to acquire, pay for and use tickets. In a multimodal public transport system, it is desirable for tickets to be useable for all sectors of a journey, including the use of different routes and different modes; it is inconvenient if separate tickets must be purchased for each sector of a trip. An electronic stored-value "smart-card" system, available on all modes throughout the network, regardless of operator, is becoming common in large cities, and such a system will be appropriate for Maputo in the long term.

A balance must be found between a simple, inexpensive manual system, which is less convenient to use, provides poor security and little information, to a more user-friendly, secure system which generates valuable control and planning data. As technology improves, however, more sophisticated systems are becoming more affordable, and for the long term it is desirable that a ticketing system is developed to meet the specific requirements of the Greater Maputo system.

F.6.3 Options

(1) Regulation or Deregulation of Fares

Control of fares by government protects passengers from exploitation by operators through the charging of excessive fares, although even with rates controlled they may be circumvented through such practices a route-cutting. However, over-zealous protection of passengers by limiting the level of fares, and granting increases only infrequently, undermines the operators' viability, with undesirable results. Deregulation of fares has been advocated, and implemented in some cities, on the assumption that market forces will find the appropriate level, but in practice this is rarely achieved.

For a coordinated urban transport system, there should be consistency of fares and structures on all services, and this can only be achieved with regulation of fares. However, it is essential that the manner of regulation does not lead to the problems which have been encountered in Maputo in the past, and rates must be regularly reviewed and adjusted to ensure that all costs of providing the service are covered.

(2) To Subsidise or Not

Government may decide, as a matter of policy, that fares should be set at a level which is insufficient to cover costs. In these circumstances, operators should be subsidised so that costs are covered and a reasonable return is earned on the capital invested. If services are subsidised, fares should be controlled by government.

Otherwise, operators must have some influence over fare levels so that they are able to earn sufficient returns to sustain the operations. A suitable formula linking fares with the costs of inputs, agreed and specified in the concession contract, would meet this requirement. There must also be an equitable means of compensating operators for carrying passengers at concessionary fares or free of charge.

It has been mentioned elsewhere that with an efficient public transport industry, operating in a suitable environment, it should be possible to provide an adequate service at affordable fares without subsidy. For this to be achieved, a number of requirements must be met, including formalisation of the industry, appropriate vehicles, appropriate regulations, effective enforcement, and measures to control road traffic to minimise delays to bus services.

(3) Different Fare Structures

There is a choice of a range of fare structures from a flat fare to a finely graduated structure. In many respects a finer scale is preferable to a coarser scale, but the finer the scale the more difficult it is to administer and enforce. An appropriate balance must be found.

As well as varying fares according to distance, it is often appropriate to differentiate between peak and off-peak travel. Demand is higher at peak times, as are costs, and some operators charge higher fares at peak times than at off-peak times to encourage passengers who are able to travel at these times to do so. As with a fine fare scale, this has several benefits but complicates the revenue collection and control procedures.

The question as to whether or not all fares for TPM services should remain lower than those charged by the private sector will become significant if the TPM operation is increased substantially. Ideally, TPM fares should be increased to the same level as *chapa* fares; however, if this is not possible, an option would be for the lower fares to continue to apply for existing buses, but for the higher fares to be charged on all new buses introduced on TPM services.

(4) Ticketing Systems

The ticketing options range from low-cost systems with limited capability to high-cost complex systems. Complex ticketing systems are required not only for good revenue security and generation of information, but also to enable the implementation of complex fare structures.

F.6.4 Recommendations

Regulation or Deregulation of Fares

Public transport fares in Greater Maputo should be regulated by government. Fare scales and structures must be consistent throughout the whole of Greater Maputo, and should be determined by the Transit Authority.

Fares should be adequate to cover all costs of providing an efficient public transport service, including the costs of overheads, purchase, maintenance, operation and replacement of vehicles and other equipment, and all labour costs.

Public transport fares should be reviewed at least once per year and adjusted as necessary on a regular basis to ensure that all increases in the cost of inputs are fully compensated for.

Subsidy

Public transport services should not be subsidised unless government requires certain services to be operated at fares which do not fully cover their costs, in which case the operator should receive full compensation in the form of a subsidy.

If government requires certain classes of passengers to travel at reduced concessionary fares, operators should be reimbursed for the resulting revenue shortfall. This may be administered through the ticketing system, which should therefore have this capability, although this will not be practical for all services in the short term.

The fuel rebate currently applied to the *chapas* should be progressively phased out with reductions being effected at each fares increase.

Fare Scale and Structures

TPM fares should be increased to the same levels as the *chapa* fares with immediate effect. If this is not possible for all TPM buses, the present low fares should continue to apply only on existing buses, and the higher fares should be charged on all new TPM buses introduced from now on.

Fare rates for buses and *chapas* should be reviewed and increased not later than November 2013.

The existing flat/coarse fare scale should be replaced by a graduated scale, related to distance travelled. Initially the fare structure should be kept as simple as possible, while catering for the difference in cost between long and short routes. A zonal fare system, with a flat fare within each zone and a higher fare for journeys crossing zone boundaries, would meet this requirement. It will be necessary to carry out a study to determine the appropriate size of the zones, and location of the boundaries: this should be undertaken as part of the recommended route network study.

As the system develops and becomes more organised, more sophisticated fare collection systems may be introduced, enabling more complex fare structures to be implemented.

Ultimately it will be possible, using smart card technology, to have distance-based fares with peak and off-peak differentials and other refinements including intermodal ticketing, but such sophisticated systems should not be considered in the immediate future.

Initially, it is recommended that fares should be based on distance, with a coarse scale with increments after every 5 km travelled. It is recommended that when fares are increased in November 2013, the existing MT 7.5 fare should be retained for journeys of up to 5 km, with a MT 10 fare for 5–10 km, MT 12.5 for 10–15 km, and MT 2.5 increments for each subsequent 5 km stage.

Chapas should be permitted to charge flat fares for a route of any length, provided that it conforms with the approved scale, and provided also that other *chapas* operate the shorter sections of each route as applicable. TPM should implement an appropriate ticketing and inspection system to cater for the new fare structure.

This should be monitored through surveys to determine the numbers of fares collected at each value, to enable the scale to be refined at the next annual increase, which should take into account all relevant inflationary cost increases.

Ticketing Systems

Tickets should be issued for all formal public transport services. A relatively low cost ticketing system should be introduced as a temporary measure.

For the longer term a system-wide smart card ticketing system should be introduced, but this must be designed to meet the specific requirements of the Greater Maputo public transport system; it is not possible to assess what these will be at this stage.

F.7 Public Transport Industry Structure

F.7.1 Existing Situation

The urban public transport industry in Greater Maputo comprises:

- Two public sector bus operators (owned by Maputo and Matola Municipalities)
- One public sector rail operator
- One public sector shipping operator
- Many small private sector road transport operators (operating buses, *chapas*, taxis and *txopelas*)
- Several small private sector ferry operators
- Illegal road transport operators

(1) Public Sector Bus Operators

TPM is one of several publicly owned public transport companies providing urban passenger transport services in Mozambique. It operates urban and suburban services in the Greater Maputo area, and a small charter operation; it does not operate long-distance services. The urban network comprises 68 routes although at present only 55 are currently operated due to a shortage of buses. Some of the routes are classified as "express", and stop only at major intermediate stops; higher fares are charged on these routes although normal buses are used. The longest route is 46 km in length.

Until 2012 TPM was owned by the Ministry of Transport and Communications, but it is in the process of being divided into separate companies, with legal ownership already having being transferred to the Maputo and Matola municipalities, and to the local authorities in smaller towns elsewhere in the country. The reorganisation was to have become effective in February 2012, although so far no physical or organisational changes have been implemented, and it is not known precisely when this will happen.

TPM operates approximately 140 buses daily, out of a total owned fleet of approximately 340. Although most of the TPM fleet is relatively new, many of the buses are unserviceable due to a backlog of maintenance and shortage of spare parts; a substantial number are also not properly specified for the types of service for which they are used.

In an urban operation, up to 95% of the fleet should be available for service at peak periods. The TPM figure of approximately 40% is therefore unacceptably low, although consistent with many public sector bus companies in Africa – and considerably better than some.

The main reason for the low vehicle availability, despite the relatively young fleet, is claimed to be a shortage of spare parts, but the lack of an effective preventive maintenance system is probably also a major factor. Purchase of buses for which spare parts are not available locally, together with the highly diversified fleet, is nevertheless a major contributory cause of the problem.

In fact, the main reason for the shortage of spares is likely to be a lack of funds. TPM is regularly short of cash to meet its immediate liabilities such as fuel and wage bills, and lacks the resources to invest in adequate stocks of essential parts. Failure to keep adequate stocks when spares are not immediately available on the local market is a short-sighted strategy since the resulting poor vehicle availability reduces the income stream further.

As a result of the shortage of spare parts, a large proportion of buses is out of service for long periods awaiting the delivery of spares, while some buses are cannibalised to provide parts for others: in practice, buses which are cannibalised are rarely returned to service.

At present, because of the shortage of buses, only one or two TPM buses are allocated to each of the routes normally operated. The shortage of vehicles, together with delays caused by traffic congestion and poor road conditions, makes it impossible to operate to schedule; existing schedules have not been modified to reflect the actual vehicle and traffic situation. As a result, it is reported that most TPM buses tend to wait for a full load at the terminal before departing, in a similar manner to the informal *chapas*. Therefore although the fares charged are lower than those for the *chapas*, passengers who prefer the lower cost alternative have a very infrequent service.

TPM employs over 1,300 staff, including over 800 drivers and conductors. This equates to over 9 employees per bus, which is at the top end of the acceptable range: for an operation of this nature in a developing country a range between 5 and 9 staff per operational bus is appropriate. Much of the excess is in the administrative area: the company reports a shortage of drivers and conductors.

TPM's financial performance is poor, due to a combination of low fare levels and high costs resulting to a large extent from inefficiency in operation, and in particular poor vehicle utilisation. In 2011 its total expenditure was MT 659 million, and revenue from operations only 336 million of which only 176 million was from fares and 152 million from hire of buses; it received a subsidy of MT 266 million.

Under the reorganisation, the assets and resources of the former TPM, including vehicles and personnel, will be divided between Maputo and Matola Municipalities with 65% being allocated to Maputo and 35% to Matola. The two new companies will cooperate with regard to routes, bus stops, schedules, fleet maintenance, information exchange and other aspects to facilitate their objectives. The two municipalities will continue to operate the existing routes, but both will be able to introduce additional routes in accordance with their own plans. The two municipal companies are authorised to operate within their own municipal and surrounding areas, and may extend their activities to other areas with Municipal Council authorisation.

Existing routes will be allocated to the two companies as appropriate; some routes will be jointly operated by both. Although the two municipalities may have different ideas and objectives, it is expected that the companies will be able to cooperate at the functional level.

The existing TPM facilities in Maputo City have been transferred to the Maputo municipality, and TPM depot facilities in Matola, which have been disused for several years, are to be refurbished for use by the Matola company. Both municipalities will share the TPM depot and

workshop facilities in Maputo, and will share the respective costs, on a temporary basis until the facilities in Matola are ready for use. No new infrastructure is to be built in the foreseeable future.

(2) Public Sector Rail Operator

The railway and ports company, CFM, is wholly government owned. It has three divisions, CFM South, Central and North. There is private sector participation in the Northern and Central Divisions but the rail services in the Southern Division are still directly managed by CFM although the management of some of the port terminals has been given to contractors.

(3) Public Sector Shipping Operator

Transmaritima is wholly government owned and currently operates two services in Greater Maputo, a ferry for vehicles and foot passengers from Maputo to Catembe, and a service from Maputo to Inhaca for foot passengers only. The Incomati River ferry at Marracuene was formerly operated by Transmaritima but is now operated by Marracuene Municipality.

(4) Private Sector Road Transport Operators

The private sector road transport operators are mostly small businesses, many owning only one vehicle. Their activities are coordinated by operators' associations, and although it is not compulsory, the majority of operators are members of one of the associations. The associations are organised largely on a geographic basis, with each representing both passenger and freight transport operators in their area, and organising all operations on specific routes; there are some exceptions: for example, in Maputo there is a separate association which represents only taxi operators.

The hierarchy of associations is headed by FEMATRO (the Mozambiquan Federation of Road Transport Associations): There are 23 associations in total representing road transport operators in Mozambique; those representing *chapa* operators in the Greater Maputo are:

- ATROMAP (Associacao dos Transportadores Rodoviarios de Maputo) which organises routes operating within Maputo.
- UTRAMAP (Uniao dos Transportadores Semi Colectivos Maputo, or Union of Maputo Transport Operators) which organises routes operating from Maputo to districts other than Matola, including Marracuene and Boane.
- UNICOTRAMA (Uniao das Cooperativas dos Transportadores Semi-Colectivo de passageiros e carga do Municipio da Matola) which organises the transport operators based in the Matola municipal area.

There is also one association representing taxi operators in Maputo:

- ATAXCIMA: Associacao dos Taxeiros da Cidade de Maputo

The *chapa* associations provide various services to members, such as assisting with arranging finance and insurance, but their most significant role is the management of routes and services operated by private sector operators, including those who are not members of any association. Their main function in this regard is to control the routes by ensuring that the vehicles used are properly licensed, and that drivers comply with regulations. Each route is controlled by one association. The associations liaise with the municipal authorities in the areas concerned, for example in the planning of routes and the allocation of vehicles to routes, but in practice the associations play a greater role in the regulation of services.

Each association employs controllers who are stationed at the main terminals. They ensure that vehicles operate on their assigned routes, and comply with the rules of the association; in theory they also ensure that vehicles and drivers hold the necessary insurance and comply with relevant regulations, particularly those concerned with safety.

The operators' associations play a key role in the planning and regulation of public transport in Maputo: in effect, they carry out some of the roles which government should perform. As such they represent a key resource in the regulation of transport services, although at present their objectives are to serve the interests of their members, and not those of the travelling public.

Most *chapa* owners have one or two vehicles, which are rented out to drivers for a daily charge. The drivers retain all fare revenue collected. Out of this, they must pay the daily charge to the owner, and all operating costs, principally the cost of fuel and lubricants, tyres, routine servicing and maintenance, fees charged by FEMATRO, road tolls, and the conductor's wage; the balance is the driver's income. The costs of the vehicle licence, taxes and major repairs, are paid by the *chapa* owner. *Chapa* owners are required to pay FEMATRO a daily fee in respect of each vehicle to cover the cost of the association's inspectors: in practice these fees are paid by drivers.

Chapas do not run to schedule, but leave the terminals either when full, or if the driver expects to pick up a full load soon after leaving the terminal. The frequency of departure is thus determined by the demand, with lower frequencies at less busy times. In theory this is appropriate, but it means that passengers wishing to board at points other than the terminals are likely to find that every *chapa* is full when it arrives, and it is difficult to find a place unless a passenger is leaving the vehicle at that point. Otherwise, the passenger may be forced to squeeze into a vehicle which is already full. Many passengers travel in the opposite direction to that in which they wish to travel in order to secure a place at the terminal to come back (paying an additional fare as well as taking extra time). Waiting times are long, and standards of comfort are low, with passengers overcrowded into vehicles which are unsuitable for the services for which they are used.

The owner's daily charge must be sufficient to cover the costs of major repairs, depreciation, licences and taxes, and provide a reasonable return on the investment. It is unlikely that the current charges are adequate to cover these costs.

It is clearly in the driver's interest to understate to the owner the amount of revenue earned, and to overstate the expenditure, in order to persuade the owner to charge as little as possible. Similarly, it is in the owners' interest to overstate expenditure on major repairs to minimise any tax liability which may be incurred. It is therefore difficult to establish accurately the costs incurred by the *chapa* operators, and the revenue earned, and a detailed study would be necessary to establish these costs. Nevertheless on the basis of observation of vehicle utilisation, and taking into account current fare levels, as well as anecdotal evidence from the associations, it is clear that revenue is barely adequate to cover the full costs of operation, maintenance and fleet replacement. The problem is compounded by inefficient operating practices. Inefficient vehicle utilisation reduces total revenue, and lack of preventive maintenance results in excessive maintenance and operating costs in the long term. The use of small vehicles on routes with high traffic volumes is an inefficient practice which further reduces the viability of these services.

For a transport service to be viable, it is important that the amount of time in revenue-earning service is maximised, and idle time waiting at terminals and bus stops is minimised. From observation it is apparent that *chapas* spend a significant proportion of their time waiting at terminals. This indicates a surplus of capacity on these routes, which reduces revenue and increases costs. Utilisation is also adversely affected by traffic congestion.

The *chapa* licences, which are issued by the municipalities, specify the route on which each vehicle must be operated. The operators' associations determine the maximum number of vehicles to be assigned to each route, and will not permit this number to be exceeded. Only three routes in Maputo currently have their full allocation of vehicles: these are Pl. Combatentes to Xipamanine via Shoprite, Baixa to Xipamanine, and Baixa to Pl Combatentes via Vladimir Lenin. Each of these routes is assigned 50 vehicles, which is said to be adequate; there is very little route-cutting (except by unauthorised vehicles) and no competition from unlicensed trucks. Enforcement of rules, by both the operators' association ATROMAP and traffic police, is good on these routes. The worst routes, with insufficient vehicles operating (but large numbers of illegal trucks), are from Museu to Zimpeto, Baixa to CMC via Maguanene, and Museu to Matendene: all are long routes.

Some *chapa* routes are also served by TPM buses and full-sized buses introduced by FEMATRO. Originally it was intended that the latter would operate on all *chapa* routes, but since there are only 50 buses they are currently used on only three basic routes, with variations. Some chapa routes are unsuitable for large buses due to poor road conditions.

Although accident statistics have not been obtained it is clear from observation that many *chapas* are driven dangerously; many are in poor condition and show signs of accident damage. Since drivers must maximise revenue they have an incentive to drive at excessive speeds in order to maximise the number of trips they can make in a day, and they are also inclined to race with other *chapas* to be first at bus stops to pick up passengers, and may obstruct other *chapas* to prevent them from picking up passengers. This practice also affects other traffic.

Chapa owners take no responsibility for driver behaviour: their primary concern is that the driver makes the daily payments for the use of the vehicle. Enforcement of driving standards is largely ineffective: although police may levy fines on drivers for committing road traffic offences this is regarded as an operating cost and does not act as a deterrent.

As well as the irregular service due to the lack of schedules as discussed above, the reliability of the *chapa* service is affected by mechanical failure. It has not been possible to determine the frequency with which *chapas* break down, but it is likely that this is frequent in the light of the obviously poor standard of maintenance.

Some full-sized buses are operated in Maputo by private sector operators. A very small number of city buses, imported second-hand, have been operated by individual owners for several years. In July 2011 FEMATRO arranged the import of 50 Ashok Leyland buses from India. They were funded through the Transport Development Fund of the Ministry of Transport and Communications as a means of easing Maputo's public transport problems, and were intended to be allocated to associations which would operate them on selected routes in an organised manner. Instead, they were allocated to individuals, and are operated on an informal basis.

The buses operate on several routes, from Museu or Baixa to Boane, Nkobe, Kongolote, T.3, Machava Socimol, Acipol, Matendene, Alberzine, Costa do Sol, and Malhampswene. Fares charged are the same as those charged for the *chapas*; paper tickets are issued to passengers. The buses do not operate to schedule, and the drivers decide when to operate, in a similar manner to the *chapas*. As with TPM, the number of buses allocated to each route is insufficient to provide a regular service, or to make any major impact on service capacity. Owners complain that they are unprofitable to operate; some have been unable to make the monthly payments and have given up their buses.

There are also long-distance inter-city and international bus and chapa services operated by the private sector. Inter-city bus services from Maputo to towns and cities throughout Mozambique

operate from the terminals at Junta and Xikelene. International services from Maputo operate from the terminals at Junta and Baixa; full-sized buses are also operated but these use only the Junta terminal. In addition, there are luxury services using full-sized buses operated by specialist companies, mostly based in South Africa. They do not use any of the large terminals in Maputo, but depart from points near travel agents' offices, generally at the roadside although there are some small off-street facilities used by individual operators.

While these long-distance operators do not contribute to the urban public transport system, their services interface with city services. Some are also potential players in the urban bus market, and may diversify into the operation of formal urban bus services. Similarly, some of the larger freight transport companies operating in Mozambique may also enter the urban bus market in future.

There are approximately 1,000 saloon car taxis operating in Greater Maputo. The number of taxis has increased significantly in recent years: in 2009 there were only 150 registered taxis, and further growth is expected although the number of licences issued is constrained by the total capacity of the taxi stands.

The taxi owners' association, TAXCIMA, has approximately 265 members, mostly owning between one and five cars. Some operators with larger fleets, such as Top Taxis, are not members. The association operates only in Maputo; taxi associations have not yet been established in other parts of Greater Maputo. The association operates a call centre for customers to call, with taxis being notified by radio. It also assists members by arranging finance.

Each taxi must operate from a stand which is specified on the licence, but is permitted to pick up passengers at the roadside after dropping passengers. Taxis are not permitted to cruise looking for passengers but may be called to specific locations through the call centre. Stands are allocated by TAXCIMA in liaison with the municipality. Taxi operators may request to be allocated to a particular stand, and if there are vacancies they will be allowed to use it; otherwise they will be allocated to an alternative stand. Taxis are not permitted to use a stand other than the one to which they have been allocated. Each stand is managed by an unpaid controller, who is one of the drivers allocated to the stand, elected by his colleagues. He ensures that only taxis licensed to operate from the stand do so.

A specified number of taxis is allowed at any stand. When this number has been reached no more taxis are allocated to the stand. This sets a limit on the total number of taxis which may be licensed in the city, although if new stands are created this will enable more taxis to be licensed. There were 45 stands in 2011; there are now well over 100. More stands are required in tourist areas, near restaurants and hotels, markets and bus terminals.

There are also approximately 300 15-seat minibuses registered as taxis, but operating as school buses. Like the *chapas* and taxis, they are owned by individuals, mostly with only one or two vehicles; their owners are not eligible for membership of TAXCIMA.

There are approximately 200 *txopelas* (three-wheel scooter-based open taxis manufactured by Bajaj in India) operating in Greater Maputo. Most are owned by individuals or small businesses.

The taxis and *txopelas* carry individuals or small groups on a point-to-point basis and do not operate on a shared basis on fixed routes as in many other African countries.

In addition to the public sector ferry operator (Transmaritima) there is a private sector operator with three boats (capacity 30 passengers each) operating between Maputo and Catembe, using the same terminals as Transmaritima. They operate like the *chapas*, and depart only when full.

Illegal operators (those operating without licences) account for a significant share of the public transport market in Greater Maputo. There are some illegal taxis but the number is falling due to the implementation of stricter regulations, including the introduction of specified colours for taxis. *Txopelas* should be licensed by the municipalities, but in fact most are not licensed to carry fare-paying passengers and are therefore operating illegally. In addition, some *chapas* operating on regular routes do not have licences, although since the restriction on licensing 15-seat *chapas* in Maputo was lifted these are now relatively few.

Some licensed *chapas* operate on routes other than those for which they are licensed if these are considered to be more attractive. Many routes are therefore served by fewer vehicles than are licensed for those routes, while popular routes often have more vehicles than are licensed or are necessary.

Illegal operation is particularly evident at peak periods, when large numbers of small and medium-sized open trucks and pick-ups, many without seats, can be seen operating illegally as *chapas* to take advantage of the shortage of capacity at these times. Many carry excessive numbers of passengers in very dangerous conditions.

According to FEMATRO, many legal operators have been forced to become illegal because they cannot afford to pay taxes and licence fees.

F.7.2 Issues

Key issues concerning the structure of the public transport industry in Greater Maputo relate principally to the road transport sector; these are:

- System capacity, efficiency and performance
- The reorganisation of TPM
- The roles of public and private sector operators
- The roles of formal and informal sectors
- The vehicle fleet
- Sustainability
- Illegal operation
- The role of FEMATRO and operators' associations

(1) System Capacity, Efficiency and Performance

The effective capacity of the public transport system is inadequate. This is particularly apparent at evening peak periods when large queues of passengers may be seen at the main city centre boarding points. Additional capacity is provided by illegal operators, usually with vehicles which are unsuitable for the purpose.

The capacity shortage is attributable both to a shortage of vehicles and to inefficient operating practices which result in low vehicle productivity. The structure of the industry is partly responsible for this situation.

TPM suffers from many of the constraints which affect most public sector organisations. Particularly relevant in the context of fleet capacity is the fact that decisions regarding vehicle purchases are made by government rather than by TPM, which has resulted in the present fleet

comprising a large number of makes and types, most of which are unsuitable for operation in Maputo, and for which spare parts are difficult to obtain. Inadequate funding has compounded the problem. In particular, the requirement to charge lower fares than the private sector, which is common practice in many countries, with inadequate compensation for the resulting deficit, has resulted in TPM being unable to maintain or develop its fleet. The level of overheads, in particular the depot and workshop facilities, are commensurate with a much larger operation, and therefore these costs must be spread over a smaller operating base.

If TPM were able to operate in a more commercial manner, without the present constraints, it would be able to make a substantially greater contribution to the city's public transport system.

However, the primary reason for the capacity shortage is the nature of the informal sector, which operates a large number of small, unsuitable vehicles in an inefficient manner. These vehicles spend an excessive proportion of their time standing idle at terminals awaiting full loads, and then have no capacity to pick up passengers en route. With this method of operation, providing additional vehicles makes no difference to the service capacity: it merely results in longer queues of vehicles waiting at the terminals.

The composition of this sector of the industry, namely a majority of small businessmen with limited financial resources or managerial ability, inevitably results in a predominance of small vehicles which are cheap to purchase and relatively easy to operate. Therefore if there is to be any significant improvement in public transport services, this is one of the key issues which must be addressed.

(2) The Reorganisation of TPM

While it is recognised that changes must be made to the constitution of TPM to enable it to operate more effectively, the plan to divide the company between Maputo and Matola will, if implemented in accordance with the present proposals, will have a seriously detrimental effect.

The reallocation of staff between the two companies is likely to create problems at senior and middle management level, where already there is a serious shortage of capacity. The posts of general manager, traffic manager and technical manager will need to be duplicated, and these are specialist roles requiring expertise which may be difficult to find in Mozambique. At lower levels, all posts which at present require only one person will need to be duplicated in the two companies, which will worsen the already excessive staff/bus ratio.

With regard to the bus fleet, the present mix of vehicle models will be duplicated, with the number of each type being split, as closely as possible, in the same 65:35 ratio between the two municipalities. This will exacerbate the existing problems which arise from the highly diversified fleet. The opportunity could have been taken to allocate all vehicles of a particular type to one or other fleet, so that each of the new companies would have only half the number of types that TPM has at present. In fact, with the number of vehicles of each type being reduced by 355 or 65% in each fleet, the proportion of spare parts which must be held for each type will increase, unless one of the companies holds all spare parts and issues to the other as required. Either way, existing problems will be compounded unless the proposal is revised.

Reactivation of the Matola infrastructure will increase overall overhead costs, and unless there is a substantial increase in the level of operation in terms of buses and kilometres operated, this will mean that each kilometre operated must carry an increased proportion of overhead costs.

(3) The Roles of Public and Private Sector Operators

At present, the private sector, through the large number of individual informal operators, makes by far the greatest contribution to the public road transport system in Greater Maputo, although it is unsatisfactory in many ways. The public sector bus operator, TPM, currently accounts for approximately 10% of all of the traffic; this, too, has its deficiencies.

It is generally accepted internationally that although government has an essential role to play in the planning and regulation of urban public transport, the private sector is more effective in operating the services themselves. A well managed public sector operator, with freedom from political constraints or the need to offer its employees similar conditions as those employed by government, could theoretically operate as effectively as a private sector organisation; however, in practice this is rarely achieved, particularly in developing countries.

A problem in Mozambique, in common with many African countries, is a shortage of expertise in the management of relatively large formal public transport businesses, such as are required for the delivery of efficient services. Any expertise which is available is usually in the public sector: again, this is the case in Greater Maputo. Therefore while it may be desirable in the long term for all urban public transport to be provided by the private sector, in the short term it is important that the expertise available within TPM should be utilised to the full; it should also form the nucleus of an expanded pool of expertise which in future years could migrate to the private sector – as indeed could TPM itself.

There is also some existing expertise in the private sector which could be developed. There are small long-distance bus and road freight transport operators who appear to operate reasonably well-run businesses, while private sector businesses in other sectors may wish, and have the capability, to diversify into transport. The informal *chapa* industry, including officials of FEMATRO and its subsidiary associations, also has expertise which could be developed for application in a more formalised system.

TPM, as a state-owned company, is also expected to provide low-cost services to assist those with low incomes: therefore its normal fares are less than those charged by the private sector. At present the service is limited due to a shortage of vehicles, so that in practice many of those on low incomes are unable to benefit.

(4) The Roles of Formal and Informal Sectors

As in virtually all African countries the public transport industry in Maputo at present is predominantly informal, with approximately 60% of all non-walking trips being made by *chapas*, and 17% by bus. However, the operating practices of the informal sector, and the types of vehicles used, are inefficient for the movement of large numbers of people, and provide a poor quality of service. As the city grows and the demand for travel increases, the deficiencies of the informal sector will become increasingly significant, and travelling conditions for the majority will become even worse.

The informal *chapa* operators are mostly small businessmen who lack the financial resources to acquire large buses, and maintain them to an adequate standard. A small number have acquired large buses, but these are low-cost vehicles, unsuitable for intensive urban operation, are poorly maintained and are operated on the same informal basis as the *chapas*. For maximum efficiency, buses should be operated on an organised, scheduled basis and this is beyond the capability of the informal sector.

To cater adequately for future requirements, a better organised, more formal system will therefore be required; the industry must make the difficult transition from the existing informal

system to one in which all mass transport services (buses, rail or water) are operated by formal businesses, appropriately planned and regulated. There have been several proposals in recent years for the formalisation of the *chapa* industry, through such measures as introducing route concessions, and encouraging the use of larger buses through licensing restrictions on buses with fewer than 25 seats, but these have had little effect. Major changes will be required within both the industry and the government agencies responsible for planning and regulating the system if the necessary improvements are to be achieved.

The mass transit services provided by the formal sector in future may be complemented by services operated by the informal sector, but these should be restricted to the provision of individual services, with small vehicles such as taxis or *txopelas*. Even these services should be regulated, in order to ensure adequate standards of safety and quality, and to avoid excess capacity.

If the *chapas* are to be replaced by a more formal transit system based on full-sized buses, the livelihoods of the many thousands of people involved in the *chapa* industry will be threatened. Some will be able to migrate to the formal sector, although the number of employment opportunities will be substantially lower than at present in the informal sector. There will also be an increased requirement for enforcement officers, and maintenance personnel to enable higher standards to be achieved: priority should be given to those displaced by the formalisation of the transport industry.

In addition, despite its shortcomings, the *chapa* industry, including the operators' associations, represents a significant resource in terms of expertise and capability which should not be wasted. Training and capacity building programmes should be arranged to provide opportunities for those with such potential.

In essence, the process of transition from the present informal system to a more appropriate formal system must be carefully and sensitively planned, and its implementation phased over a period sufficient for all adjustments to be made with minimum adverse impact. The process is likely to take up to ten years.

(5) The Vehicle Fleet

Most of the *chapas,* and many of the full-sized buses operating in Greater Maputo, are old and in poor condition. The *chapas* in particular are mostly in very poor condition. Most of the buses owned by TPM are unserviceable, while many of those operating are inappropriately specified for intensive urban service under the prevailing conditions. The older buses owned by private operators are in similarly poor condition to the *chapas*, while the 50 buses purchased by private operators within the past two years are inappropriately specified low-cost vehicles, and with low maintenance standards will become unreliable within a short time.

The *chapas* are unsuitable for the majority of services for which they are used: where large numbers of passengers are travelling on the same route, the largest buses which can be legally and safely used within the constraints of the road system are the most efficient means of transporting them, in terms of cost, use of road space and exhaust emissions.

The majority of the vehicles operating illegally to meet the capacity shortfall at peak times are totally unsuited for carrying passengers. They are unsafe, uncomfortable and are frequently grossly overloaded.

It is essential that new vehicles are brought into the system to provide additional capacity, and to replace those which are unsuitable. The limited financial resources of TPM, compounded by

the uncertainty of funding as a result of its reorganisation, has precluded any meaningful fleet development to date. The recent fares increase may encourage the acquisition of some additional *chapas*, but these will do little to improve the present situation, and will increase the number of such vehicles which will need to be phased out later.

Therefore there is a pressing need for measures to facilitate the acquisition by both public and private sector operators of suitable new vehicles, while at the same time discouraging any increase in the number of *chapas*. This is a major issue which must be addressed urgently.

(6) Sustainability

The existing *chapa* system is unsustainable. That is not to say that it will eventually cease to function altogether if no action is taken, but it will continue to deteriorate in terms of capacity, safety and quality, while costs will steadily rise in real terms. At existing levels of expenditure, income from the *chapa* services is inadequate to maintain and replace the vehicle fleet, or for the expansion in capacity which will be needed as demand increases.

Over time, fares which would cover costs will be unaffordable to an increasing number of users. Adequate subsidies are not available for the private sector at present and it is unlikely that this will change. TPM is inefficient also: in particular, the proportion of its fleet which is operated daily is unacceptably low; its overheads are too high for the present level of operation and fares are too low to cover operating costs. It can only continue to function in its present form through government subsidy.

This too is a key issue. The industry will be more sustainable if it can operate more efficiently, and this will require major structural changes, including formalisation, as discussed elsewhere. Financial sustainability can only be achieved with an appropriate fare structure and adequate fare levels: this issue too is discussed under a separate heading.

(7) Illegal Operation

The *chapa* system can survive only by disregarding regulations, and through corrupt practices. If all regulations were enforced, operators would not be able to stay in business: they are forced to break the law in order to make it possible to cover direct costs. Otherwise there would be no virtually service. In addition, if the illegal operation of trucks and pick-ups to help in meeting peak demand were to be eliminated, this would cause greater hardship for passengers.

This raises a complex issue. If all regulations were to be strictly enforced with immediate effect many chapas and other illegally operated vehicles would be taken out of service, creating a very serious capacity shortage within the transport system. On the other hands standards of safety and quality, and other traffic rules and regulations, should ideally be enforced.

Enforcement is a particularly important institutional issue. One reason for the poor standard of the public transport services is the failure by the enforcement agencies to effectively enforce relevant rules and regulations. The enforcement agencies must be strengthened and given the resources and authority to ensure that all regulations are observed.

However, this must be a gradual process which must be phased over several years: simultaneous with capacity building and strengthening of the enforcement agencies, standards should be progressively raised until full compliance is achieved.

(8) The Role of FEMATRO and Operators' Associations

The informal transport operators are likely to resist any attempt to reform the industry, and their associations will undoubtedly make representations to government on their behalf. It is essential that the associations are not able to undermine or prevent the process of reform, and this must be addressed at a very early stage.

Currently FEMATRO and the operators' associations play an important role in regulating the operations of the informal sector. If the industry is to become more formal, this role will diminish. The associations themselves may see their existence under threat, and this too must be addressed.

F.7.3 Options

The principal options regarding the structure of the public transport industry in Greater Maputo may be considered under the following headings:

- No change
- Roles of formal and informal sectors
- Roles of private and public sectors
- Vehicle fleet
- Number and size of operators
- Role of TPM in the short-, medium- and long-term
- BRT
- Capacity and Capability
- Role of FEMATRO and associations

(1) No Change

The public transport service provided in Greater Maputo is generally inefficient, inadequate, unreliable, unsafe, inconvenient, uncomfortable and offers poor value for money. Unfortunately, the present system is probably the only workable system under existing circumstances.

A possible course of action would be to leave the system as it is. However, as the city grows and the demand for transport increases, the existing problems will be exacerbated. Increasing private car ownership as well as increased demand for public transport will result in chronic traffic congestion; the inefficiencies inherent in the present system will become more pronounced, and overall the quality of the system will deteriorate substantially, while costs to the users will continue to rise in real terms.

This is not a realistic or acceptable option although it is by far the easiest.

(2) Roles of Formal and Informal Sectors

The basic options are:

- All services provided by informal operators
- All services provided by formal operators
- Formal operators providing mass transit services, and informal operators providing individual demand-responsive services

Under the first option, the existing unsatisfactory situation will be perpetuated, and as the city grows, the existing problems will become worse. This is not a suitable option.

It is possible for all services, including scheduled bus services and demand-responsive services to meet individual requirements, such as taxis, to be operated by formal companies. However, while it is desirable that planned and scheduled services should be provided by formal operators, there is no particular advantage in individual services being provided by formal companies rather than by individuals operating informally. In the context of Maputo, eliminating informal operators, even for scheduled services, will be difficult, and there is no point in making the task even more difficult by attempting to formalise the taxi and *txopela* operators in addition to the *chapa* operators.

The most appropriate option is therefore a mix of formal and informal operators, with the formal operators providing mass transit services, and informal operators providing individual demand-responsive services.

(3) Roles of Private and Public Sectors

The basic options are:

- All public transport services provided by private sector operators
- All public transport services provided by public sector operators
- Public transport services provided by a mix of public and private sector operators

Current government policy states that the private sector should be responsible for provision of services; if the public sector is involved in service provision, this should be in partnership with the private sector, or as an operator operating commercially, on an equal footing with the private sector. In big cities the preference is for big public companies, in partnership with the private sector. However, the definition of "partnership" is not clear, although it is understood that the term is generally used to describe a situation in which services are operated by the private sector under some form of contract or concession awarded by local government authorities. It may therefore be presumed that government policy supports a system in which urban public transport services are planned and regulated by the public sector, but delivered by private sector operators. This conforms to international best practice.

It is possible for all public transport services to be provided by public sector operators but in practice this is rarely successful, particularly in developing countries, and is not considered to be a viable option for Maputo. In Mozambique, and in all other African countries, governments have been unsuccessful in running efficient transport services. Virtually all public sector road transport undertakings have been unprofitable and have required large subsidies; they have been unable to maintain their vehicles effectively so that only a small proportion of the fleet is operational, and vehicle lives are short; many have become bankrupt and ceased to operate altogether. TPM has many of the characteristics of such an organisation.

Transport services may be provided by a mix of public and private sector operators, but unless the public sector operators have the capability to operate as efficiently as the private sector operators, this too is not a satisfactory option. However, this presupposes that there are efficient private sector operators, and at present this is not the case in Maputo: despite their shortcomings, the TPM companies are the most efficient operators and in the short term are essential for the provision of formal bus services.

The most appropriate short-term option is therefore to continue with the present private/public sector mix, with TPM being strengthened to enable it to increase its contribution to the system. In the longer term, the development of new formal private sector bus operators should be actively encouraged to complement TPM's services.

Ultimately, the TPM companies may be privatised so that all services are provided by the private sector. However, there is no reason why the two new municipal companies, if they remain in public ownership, should not operate alongside private sector companies, provided that they are able to operate at an acceptable level of efficiency, and that all operators are subject to identical rules and conditions, regardless of ownership.

(4) Vehicle Fleet

The basic options for the provision of mass transit services are:

- Predominance of small vehicles
- Predominance of large vehicles
- Mix of types and sizes
- Standardized fleet

It has already been explained that small vehicles are inefficient as a means of carrying large numbers of passengers. Therefore a system with a predominance of small vehicles, as at present, is not a satisfactory option.

The public transport requirements of Greater Maputo can best be met by a fleet comprising mainly large buses. However, there will still be a requirement for some smaller buses for routes where road conditions are unsuitable for larger vehicles, or where demand is low, so that the operation of large buses would mean that they would either operate with surplus capacity, or at unacceptably low frequencies. A fleet comprising only maximum-sized buses would therefore be inappropriate.

The advantages and disadvantages of a standardised fleet must also be considered. There are substantial potential benefits to be gained from standardisation in larger fleets, including reduced requirement for spares stockholding, and therefore reduced inventory costs, and reduced costs resulting from purchasing power through purchasing in large volume. Mechanics' familiarity with a particular model can result in improved maintenance standards, while the requirement for special tools is reduced. Similarly, drivers are likely to drive more safely and with more sympathy for vehicles if they are required to drive only one type of vehicle with which they are familiar. A standardised fleet can also present a more professional image to the public.

There are, however, real or potential disadvantages to be aware of, particularly if standardisation is taken to extremes. A standard vehicle may not be suitable for every task, and in a highly standardised fleet it may be necessary to compromise with vehicles specified for all types of services operated, without being ideally suited to any of them. Too rigid application of a standardisation policy may also discourage innovation, for example by perpetuating obsolete models. It may put an operator at a disadvantage with its supplier, which in effect has a monopoly position. With a policy of standardisation, therefore, it is important that whenever new vehicles are to be acquired, consideration must be given to the possibility of selecting a new standard model: the advantages of a new model may outweigh the advantages of continuing to purchase the existing standard model.

Some undertakings practice a high degree of standardisation, not only with all vehicles being purchased from the same manufacturer, but also with standardisation of units such as engines and gearboxes. In some fleets, where vehicles are purchased from different manufacturers, standardisation of units is still possible where manufacturers fit components produced by third parties, as is particularly common amongst premium chassis manufacturers. Standardisation is usually beneficial in fleets of ten or more where all vehicles are required to undertake similar

work; it is normally desirable to standardise on no more than two or three models in fleets of up to 100 vehicles, while more than three models may be appropriate in fleets of over 100.

The most appropriate option is for a fleet comprising a mix of types and sizes, so that every service can be operated by the most suitable type for that service. Standardisation should be practised to a reasonable extent but should not be taken to extremes.

It is estimated that to meet the medium-term urban transport requirements of Greater Maputo with conventional buses alone, and with an appropriate mix of types and sizes, a fleet of approximately 2,000 would be required.

The basic options for the provision of individual transport services, such as taxis, are similar, but the considerations are different. Clearly, this sector of the market requires small vehicles, and while there is a limited requirement for vehicles capable of carrying larger groups of people, and for special categories such as schoolchildren, the existing taxis and minibuses are appropriate for most requirements.

(5) Number and Size of Operators

From the viewpoint of the regulatory authority, the fewer the number of operators to deal with, the easier will be the task of supervising them: thus a single large operator is preferable to many small ones. However, in practice this is not achievable.

The basic options for the provision of mass transit services are:

- One operator providing all services
- A small number of operators, all of similar size
- Several operators, of a range of sizes
- A very large number of operators, most with only one vehicle

It is possible for all public transport services in an urban area to be provided by a single operator, but this is very rare, particularly in developing countries. Where it is the case, the operator is usually a public-sector operator. The main disadvantages are that management and organisational problems increase significantly beyond a certain size (typically between 1,000 and 1,500 buses), and there is a risk in being wholly reliant on a single operator, which may fail at any time.

In Mozambique, the capability to manage small to medium-sized companies is very limited at present, and even within the time scale of the Master Plan is unlikely to develop sufficiently for the effective management of very large companies. This is therefore not a realistic option.

Urban bus services should ideally be provided by a relatively small number of medium sized to large operators. It is generally accepted that urban public transport is best provided by large operators operating under concessions rather than by many small operators. Since each route should be operated by a single operator, the minimum size of each, in terms of the number of buses owned, should be sufficient to operate one route in its entirety. This would be of the order of twenty buses or more.

There could be a separate operator for every route, which would result in a large number of operators with a range of sizes according to the requirements of each route: the range is likely to be between 20 and 60 buses. Alternatively, operators may be allocated packages of routes, arranged so that their combined fleet requirements are similar.

In practice, different operators will have different levels of capability. Some will be at their maximum efficiency with a small single-route operation; others may be comfortable with a single route, but requiring a larger number of buses; while others may be capable of managing a large fleet of buses serving several routes.

The preferable option therefore will be for a system involving several operators, of a range of sizes, each operating one or several routes. The ultimate structure for Maputo is likely to be one with up to twenty operators, with between 20 and 500 buses each. This sector of the industry will reach its own balance, but the regulatory authority will have a key role to play in ensuring that route contracts are awarded to operators with the necessary capability and resources.

The same options apply to the provision of individual transport services, such as taxis, but the considerations are different.

Individual services do not require scheduling in the way bus services do, and therefore individual taxi owner-drivers can make a reasonable living and provide a useful contribution to the system without compromising safety or quality standards. On the other hand, large operators which can market their services and coordinate their activities through call centres and control centres, also have advantages; similar services may, however, be made available to individual owners through their operators' associations.

The regulatory authority's main role in respect of this sector of the industry will be to ensure that all operators meet the requisite standards, and to ensure that the number of licences issued does not result in excess capacity.

(6) Role of TPM in the Short-, Medium- and Long-Term

At present, TPM is a key component of the public transport industry in Greater Maputo, and it will be some time before other formal bus operators will be capable of making any significant contribution to the system. It is therefore essential that its potential is realised to the full: while this potential may be limited at present, this must be developed as far as is possible. TPM's situation is complicated by the reorganisation which is currently in progress, and it is important that this is not allowed to diminish the company's capability. It is also necessary to consider what role TPM should play in the short-, medium- and long-term.

The basic options with regard to TPM's role are:

- TPM to continue in its existing form (after sub-division)
- TPM to be the major operator
- TPM's role as a provider of low-cost services to be reduced or abolished
- TPM to remain in public ownership but operate commercially alongside private sector operators
- TPM to be privatised

TPM may continue in its existing form, after the sub-division between the Maputo and Matola municipalities is completed. It should be emphasised that it is desirable to delay implementation of this process until the necessary capacity has been developed for both companies to be managed effectively as wholly independent entities, and this is likely to take at least two to three years.

After the sub-division, it is important that both companies reach an appropriate size, in terms of the number of operational buses, to support the level of overheads inherited from the former national company; it is not appropriate at this stage to invest in new infrastructure for either

company, although replacement of the existing depot and workshops by new facilities, in appropriate locations, should be included in the longer-term plans.

The companies may then become established as the nucleus of the formalised bus industry, to set standards, and provide a training ground, for future operators. Eventually, the companies would operate on equal terms to the private sector operators, and would compete on an equal basis in the bidding for route licences.

The two TPM companies may be major operators, with the majority of licences, with a minority of routes operated by the new private sector operators. In the short term this is likely, but in the long term it is to be hoped that there will be sufficient capacity within the private sector for the latter to take a leading role. Nevertheless, if the TPM companies are genuinely more effective than their competitors, and provided that the bidding process is administered fairly, they may continue to dominate the market.

TPM currently provides services at fares lower than those charged by the private sector in order to assist those with low incomes. The resulting shortfall between operating cost and revenue is compensated for through a government subsidy. At present the service is limited due to a shortage of vehicles. However, if TPM's level of operation is expanded significantly, and if all are operated at the current low fares, not only will many higher-income passengers benefit unnecessarily, but the requirement for subsidy will increase substantially. Government must decide whether this is acceptable; if not, the increase in TPM's operation, while desirable, would not be financially sustainable.

The recommended option therefore is to abolish the requirement for TPM to provide services below cost; if this is not possible for any reason, an alternative would be to continue to operate the present level of service at low fares, but for all journeys operated by the newer buses to be charged for at the same fares as apply to the informal sector.

Since the TPM companies should compete on equal terms with other operators, it is essential that they should operate on the same commercial basis also, even if they remain in public ownership. This is less of an option than a basic requirement.

In the longer term, there is the option of privatising the TPM companies. This reflects government policy, and in fact the possibility of a joint venture with the private sector has been suggested in the past. However, this is an issue which should be considered only when the formal sector of the industry has become firmly established.

(7) BRT

When BRT services are introduced, operators will be required which have the critical mass as well as the capability to operate the services.

The basic options are:

- Separate operators for BRT and other services
- One private sector operator operating all BRT services
- TPM operating all BRT services
- Several private sector companies each operating only BRT services
- Some BRT services to be operated by TPM and some by private sector

In the case of a closed system, using vehicles to a different specification from those used on other services, a separate fleet of buses is required. This fleet may be owned by an operator

which only operates BRT services, or may form part of the fleet of an operator which also runs normal services. Some of the operating systems and procedures for a closed system also differ from those for normal bus services, and this, together with the special vehicle requirement, necessitates keeping the BRT and other operations separate. This may be achieved by creating separate divisions within a single large company, or by allocating BRT and other services to different operators.

The number of closed BRT routes, and the number of buses required for each, will influence the number of operators required: a third key factor is the number of potential operators available. In the short term it is unlikely that suitable private sector operators will be found within Mozambique and unless implementation of the BRT is delayed for several years, it is likely that the only practical option will be for either or both of the TPM companies to take on the task. Subsequently, as the formal private sector expands, other operators may enter the market through the competitive bidding process.

(8) Role of FEMATRO and Associations

Formalisation of the public transport industry will result in many of the functions of the operators' associations unnecessary, and there may be resistance to the proposed changes from the operators which in turn would be taken up by the associations. Therefore there will be considerable interaction between the associations and the implementing authority throughout the process.

At the same time, there will be new or increased regulatory requirements, such as the need to ensure that timetables and schedules are adhered to, and that passengers are charged, and pay, the correct fares. There will also be a need to enforce higher standards of conductor and driver behaviour, and to ensure that all licence conditions are complied with in full.

The associations already have experience and expertise in enforcing their own rules, although these rules are designed to protect the interests of their members rather than those of the travelling public. Nevertheless if this expertise can be redirected to promoting the more formal operations required in the future, this will not only provide a valuable resource but will also provide employment for many who may otherwise be displaced.

It will be essential to ensure that FEMATRO and the operators' associations cooperate in the implementation of any changes. Such cooperation is more likely to be forthcoming if the associations are fully involved in the process; moreover, they should be able to assist in encouraging their members to formalise into properly constituted organisations which are eligible to bid for licences to operate the new services.

It is important that the roles of FEMATRO and its subsidiary associations is clearly defined.

The basic options are:

- FEMATRO continues in its present form, with present functions
- FEMATRO assists in restructuring

Allowing FEMATRO to continue in its present form, with its present functions, will impede the process of formalisation of the industry and other elements of the Master Plan. Its primary function is to represent the interests of its members, virtually all of whom operate in the informal sector. Many are likely to resist any change which is perceived to threaten their businesses, and as their representatives, the associations must endeavour to protect their interests.

This situation must be avoided, and government must ensure FEMATRO's cooperation and assistance in the implementation process. The operators' associations are generally in favour of the industry becoming more formalised, with larger companies operating on a more organised basis than at present. Regular meetings and seminars have been organised by FEMATRO and its member associations, to discuss these policy issues and related matters. Some associations are reported to have formed cooperatives to operate on a more formal basis, but they are unable to raise finance to purchase vehicles because of the poor earning potential, and therefore continue to operate on an informal basis.

These initiatives must be built on to gain the associations' support. They must first be persuaded to convince their members that the proposed changes are necessary and inevitable, and that it is in their interests to adapt: while not all existing owners and operators will have a place in the new system, the associations will endeavour to ensure that as many of their members who so wish are redeployed within the new system. They must also assist in identifying alternative livelihoods for those who are displaced.

Many of the senior officers of the associations are transport operators, and some may be eligible to formalise and develop their own business as part of the reform process. Employees and appointees of the associations who currently perform regulatory and enforcement roles may have potential for retraining for equivalent roles within the formal sector.

F.7.4 Recommendations

(1) Formalisation of the Industry

The present informal structure of the mass public transport industry in Greater Maputo is incapable of meeting future requirements and must be changed.

(2) Roles of Formal and Informal Sectors

All mass transit services should be provided by formal operators, with services being provided by conventional buses (mostly high-capacity) operating to schedules designed to meet passenger demand as efficiently as possible. Each operator should be a formal entity, such as an association, cooperative, partnership or company. It should have a formal management structure with appropriately qualified full time management officers, and adequate office, depot and workshop facilities. The route network would be planned by the proposed Transit Authority, and each route would be operated exclusively by one operator, under licence to the Authority, awarded to operators on the basis of competitive bids.

The role of the informal sector would be greatly diminished, and would be restricted to taxis or *txopelas* providing individual demand-responsive individual point-to-point services.

(3) Roles of Private and Public Sectors

Public transport services should be provided by the two municipal TPM companies, together with a number of formal private sector operators. Ultimately, the TPM companies may be offered for sale as going concerns to private investors, so that all services will be provided by the private sector.

(4) Vehicle Fleet

Rigid single-deck buses up to 12 m in length and carrying approximately 100 passengers should be used on the majority of routes, with longer articulated buses, carrying 200 passengers or more, on the busiest routes where road conditions permit. *Chapas* should be progressively phased out, and replaced with a smaller number of large buses, which should be operated on a

scheduled basis by formal bus operators. The large buses should be complemented by smaller buses of various types and sizes, so that every service can be operated by the most suitable type for that service.

Standardisation should be practised to a reasonable extent but should not be taken to extremes.

It is estimated that to meet the medium-term urban transport requirements of Greater Maputo with conventional buses alone, and with an appropriate mix of types and sizes, a fleet of approximately 2,000 will be required. The present fleet is grossly inadequate and additional vehicles should be acquired as soon as possible to prevent the capacity deficiency being met by additional chapas. New buses must be to appropriate specifications for operation in Maputo (unlike most existing buses) and some unserviceable TPM buses may be refurbished as a short-term measure. The buses operated by the private sector should eventually be replaced by more appropriately specified vehicles.

The sector of the market catering for individual transport services, such as taxis, requires small vehicles, typically saloon cars. These should be supplemented by some larger vehicles, such as 15-seat minibuses or 25-seat midibuses, for larger groups.

(5) Number and Size of Operators

Each bus route must be operated exclusively by a single operator: this will establish the minimum operator size, in terms of the number of buses operated. An operator may be allocated more than one route, depending on resources and capability. The formal bus sector will therefore comprise several operators, of a range of sizes, operating one or several routes.

The formation of large private sector bus companies on a similar scale to TPM should be encouraged, and the ultimate structure for Maputo is likely to be one with up to twenty operators, with between 20 and 500 buses each, with each operator running at least one entire route, and some running several. This sector of the industry will reach its own balance, but the regulatory authority must ensure that route contracts are awarded to operators with the necessary capability and resources.

Taxis may be owned by individuals or by companies of various size, and this sector of the industry should be allowed to establish its own mix of sizes. The regulatory authority's main role in respect of this sector will be to ensure that all operators meet the requisite standards, and to ensure that the number of licences issued does not result in excess capacity.

(6) Role of TPM in the Short-, Medium- and Long-term

Physical sub-division of TPM between the Maputo and Matola municipalities should be delayed until the necessary capacity has been developed for both companies to be managed effectively as wholly independent entities; this is likely to take at least two to three years.

After the sub-division, it is important that both companies reach an appropriate size, in terms of the number of operational buses, to support the level of overheads inherited from the former national company; it is not appropriate at this stage to invest in new infrastructure for either company, although replacement of the existing depot and workshops by new facilities, in appropriate locations, should be included in the longer-term plans.

The companies should become established as the nucleus of the formalised bus industry, to set standards, and provide a training ground, for future operators. Eventually, the companies should operate on equal terms to the private sector operators, and compete on an equal basis in the bidding for route licences.

The TPM companies must compete on equal terms with other operators, and operate on the same commercial basis, even if they remain in public ownership.

TPM should cease to be a low-fare operator. Its fares should be identical to those charged by other operators; if this is not permissible for political reasons, services currently operated by TPM should continue to be provided at low fares (but if possible should be gradually phased out), but the same fares should be charged for all journeys operated by any additional buses as are charged by the private sector.

In the longer term, there is the option of privatising the TPM companies, but this issue should be considered only when the formal sector of the industry has become firmly established.

(7) BRT

In the case of a closed system, a separate fleet of buses will be required for operation on the busway. This fleet may be owned by an operator which only operates BRT services, or may form part of the fleet of an operator which also runs normal services. In the latter case a separate division should be created for the operation of the BRT services. BRT services may be operated by one company or by several, but each route should be operated by only one company.

When BRT services are introduced, operators will be required which have the critical mass as well as the capability to operate the services. In the short term it is likely that the only practical option will be for either or both of the TPM companies to take on the task of operating the BRT services. Subsequently, as the formal private sector expands, other operators may enter the market through the competitive bidding process.

(8) Role of FEMATRO and Operators' Associations

Government must ensure FEMATRO's cooperation and assistance in the industry restructuring process. The associations must be persuaded to convince their members that the proposed changes are necessary and inevitable, and that it is in their interests to adapt. The associations must endeavour to ensure that as many as possible of their members who so wish are redeployed within the new formal system. They must also assist in identifying alternative livelihoods for those who are displaced.

Many of the senior officers of the associations are transport operators, and some may be eligible to formalise and develop their own business as part of the reform process: they should be encouraged to do so. Employees and appointees of the associations who currently perform regulatory and enforcement roles may have potential for retraining for equivalent roles within the formal sector and this should be implemented wherever possible, with the assistance of the associations.

F.7.5 Implementation Considerations

The transition from the present to the proposed industry structure will take time. Several thousand people depend on *chapas* for their livelihoods, and the process must be managed carefully and sensitively. It is estimated that the whole process will take up to ten years in order to minimise the negative impact on those engaged in the informal sector.

Despite its shortcomings, the chapa industry, including the operators' associations, represents a significant resource in terms of expertise and capability which should not be wasted. As part of the transition process, it is desirable that the *chapa* operators who wish to remain in the business should be given the opportunity to adapt to the more formal operating environment.

The *chapas* themselves should be progressively phased out on a route-by-route basis across the entire conurbation, and replaced by larger buses. As each route is converted to bus operation, the worst of the displaced *chapas* should be disposed of, while those remaining should be redeployed to other routes, replacing the worst vehicles on those routes.

The process should commence with the routes carrying the greatest number of passengers on the main corridors, commencing with the group of routes between Maputo and Matola, and those on the EN1 corridor. The *chapas* would progressively be concentrated on direct services from low-density residential areas or areas served by narrow roads to central Maputo/Matola, and later only on peripheral routes connecting suburbs (and small polycentres), not operating through the central area, connecting with the formal bus or BRT services. Some of these remaining *chapas* may be replaced by buses of similar size, but operated more formally.

As the formalisation proceeds, individual *chapa* owners will have to either exit the industry, or dispose of their vehicles and combine into groups to form more formal businesses, such as cooperatives, partnerships or companies. These entities should invest in a smaller number of buses (to specifications approved by the Transit Authority), and would eventually become eligible to apply for licences to operate formal bus services planned by the Transit Authority.

Initially the present operators would require assistance in establishing the new entities, and in setting up internal organisations capable of running bus services to the specified standards. A technical assistance project to assist with this process is recommended.

At the same time as the formalisation process, and complementary to it, should be a progressive strengthening of the enforcement of all rules and regulations governing the operation of public transport services, in particular those concerning vehicle condition and safety. This is a difficult task but one which is essential if any improvement is to be achieved, and tackling this must therefore be a priority. Effective enforcement would result in improved driving standards, safer vehicles, and more reliable services as well as compliance with licensing conditions.

This too must be carefully phased. If implemented too quickly it would actually worsen some of the existing problems. The system is able to function at present only because drivers and operators are able to break many of the rules. Effective enforcement of vehicle safety regulations would ensure that all vehicles operated were in a safe and roadworthy condition, but many are currently in such poor condition that it would be uneconomic to refurbish them to an acceptable standard. This would result in a reduction in the number of vehicles operating, while the expenditure on those vehicles which are refurbished would result in increased costs. Prohibition of overloading would further reduce the capacity of the system. In addition, operators would be forced to charge the approved fares, so that their revenue would decrease, unless a substantial fares increase were approved. The increased costs, reduced revenue and reduced capacity would have disastrous results unless new buses were available to replace the *chapas*.

The pace of implementation of more effective enforcement measures must therefore be consistent with the rate at which new buses are introduced to the system, so that the capacity of the *chapas* eliminated from the system is equaled by the capacity of the new buses.

With the formalisation of the industry, there will be a greater proportion of employees, and a smaller number of owners and employers than with the present system. Therefore the emphasis of FEMATRO's member associations may change from being more oriented to the employers, to being more focused on protecting the interests of the employees. An important part of the formalisation process must be to ensure that the new operators have appropriate personnel

policies to minimise any industrial unrest. FEMATRO must be involved in this process, and should cooperate with the transport operators at all levels.

F.8 Capacity Development Requirements

F.8.1 Key Issues

An essential requirement in improving the provision of public transport services is the capability of the various institutions, in both the private and public sectors, to perform their respective roles effectively. At present, most of the organisations involved in the delivery of public transport services lack the necessary resources in terms of suitably qualified personnel, equipment or funding, and in many cases all three, to carry out their tasks effectively.

If service standards are to be improved, and service levels expanded to cater for predicted growth in demand, it is essential that the necessary capability within all relevant institutions is developed to meet not only existing but also future demands, and to be able to continuously adapt the total public transport system in tune with changing circumstances. For the bus operators, it is particularly important to instill the capability to manage a business which is financially sustainable.

During the Master Plan study, meetings and discussions were held with local government officers, transport operators and their associations. While many of the people met by the JICA Project Team are clearly competent, conscientious and dedicated to their work, it is also clear that many lack the capacity to carry out their tasks effectively.

There are several reasons. A common reason is a lack of understanding of the role to be performed: officers and managers have been given various responsibilities, but have not always been given proper instructions or guidance, and are often unaware of the sources of information which would assist them in their work. In particular, some of the municipal officers responsible for public transport are unclear as to their roles, and do not have key information to hand: they clearly do not know what information could be useful to them in monitoring public transport in their areas.

Lack of training in basic transport management principles is a factor in the poor performance of the public transport industry. For example, the poor quality of some of the management information available within TPM indicates that the company's management is not fully aware of the value or use of management information, and guidance in this area would greatly improve their capacity. The private sector transport operators have very limited knowledge of operating principles and this is one reason for their unsatisfactory operating practices.

Capacity building will be essential for the enforcement agencies, for the regulatory agencies and the proposed transport authority in particular, as well as for the transport operators. This will require a continuing programme of technical assistance which should continue throughout the transition phase from informal to formal public transport.

An essential part of the implementation process will therefore be capacity building in both public and private sectors. A lack of expertise and experience in all areas is a contributory cause of the present problems, and unless this is rectified the recommended measures will certainly fail.

This must be addressed through the appointment of advisers where necessary to provide temporary assistance and on-the-job training, appropriate internal and external training programmes, and technical assistance, particularly in the early stages of implementation.

However, such expertise as is available, for example in the public sector bus companies and for certain functions of the operators' associations, should be utilised to the full.

F.8.2 Capacity Building Training Seminars

In addition to on-the-job training, which will be a vital component of the capacity building programme, there will also be a requirement for formal training programmes.

Training seminars should be arranged for selected stakeholders in order to develop their capacity in relevant fields. The seminars should include those involved in planning and management of transport services, in both public and private sectors. Participants should include municipal officers who are directly involved in the planning and control of public transport services in their areas; senior and middle management of the two municipal bus companies (currently TPM); and representatives of the operators' associations in Greater Maputo.

The subjects to be addressed by the seminars should include:

- Principles of Public Transport Planning and Regulation:
  - Network Planning
  - Coordination of Modes
  - Fare and Subsidy Policy
  - Licensing Options
  - Enforcement
  - Public Relations

- Principles of Public Transport Operation:
  - Service Planning and Monitoring
  - Vehicle Utilisation
  - Bus and Crew Scheduling
  - Revenue Control
  - Vehicle Selection
  - Vehicle Maintenance
  - Management Information Systems

While some of the topics are more directly relevant to the municipal officers than to the transport operators and vice versa, it would be valuable for all participants to gain an understanding not only of the tasks they are involved in directly, but also of other tasks involved in the overall provision of a public transport service. This will enable them to understand not only their own roles, but where they fit into the overall picture, which is essential if the Greater Maputo public transport system is to work in a fully coordinated and organised manner.

(1) Study Tours and Secondment

It will also be beneficial for some officers within both the regulatory agency and the operating companies to visit similar organisations in developed countries where the formal processes and procedures recommended for Maputo have been practised for many years. In some cases brief study tours will be appropriate, to provide a general overview of the various systems; in others, particularly for middle management officers, longer term secondments, which involve working with the officers carrying out the various tasks and gaining hands-on experience, will be highly effective.

It is recommended that Portugal should be the first choice in order to minimise language difficulties. Brazil may also be appropriate for certain specialised roles, particularly those

connected with BRT operation and regulation: to some extent this will depend on the nature of the system selected for Maputo. Other developed countries may be selected for individuals who are fluent in other languages.

F.9 Proposed Public Transport Projects and Phasing

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

Table F.5: Summary of Public Transport Measures and Phasing

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

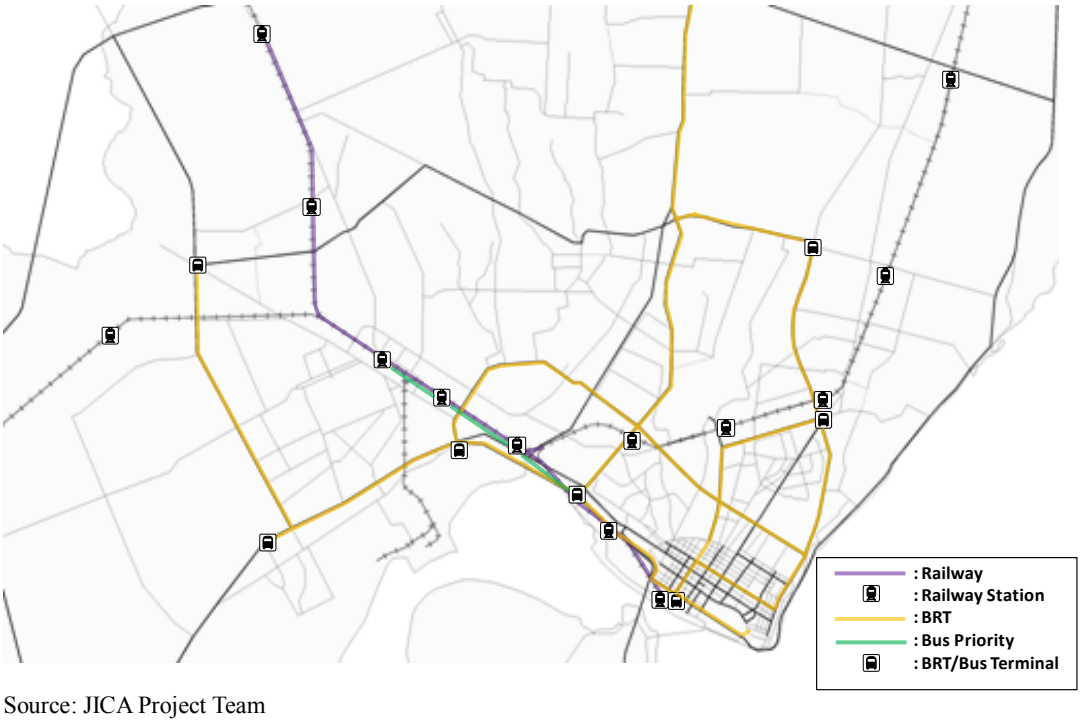
Source: JICA Project Team

The implementation of the mass transit components of the integrated public transport network has been set out in three major phases. Phase 1 covers the short term (to 2018; see Figure F.27) and includes the proposed first phase of BRT covering the high demand section between Maguanine/Xiquelene/Praça dos Herois and the Baixa, and the BRT link from the N1 corridor to Baixa. This corridor offers several alternative solutions and is not given in further detail in this diagram An additional bus priority corridor is included. No rail is included in Phase 1 because of the short timescale.

Source: JICA Project Team

Figure F.27: Proposed Mass Transit Network for 2018

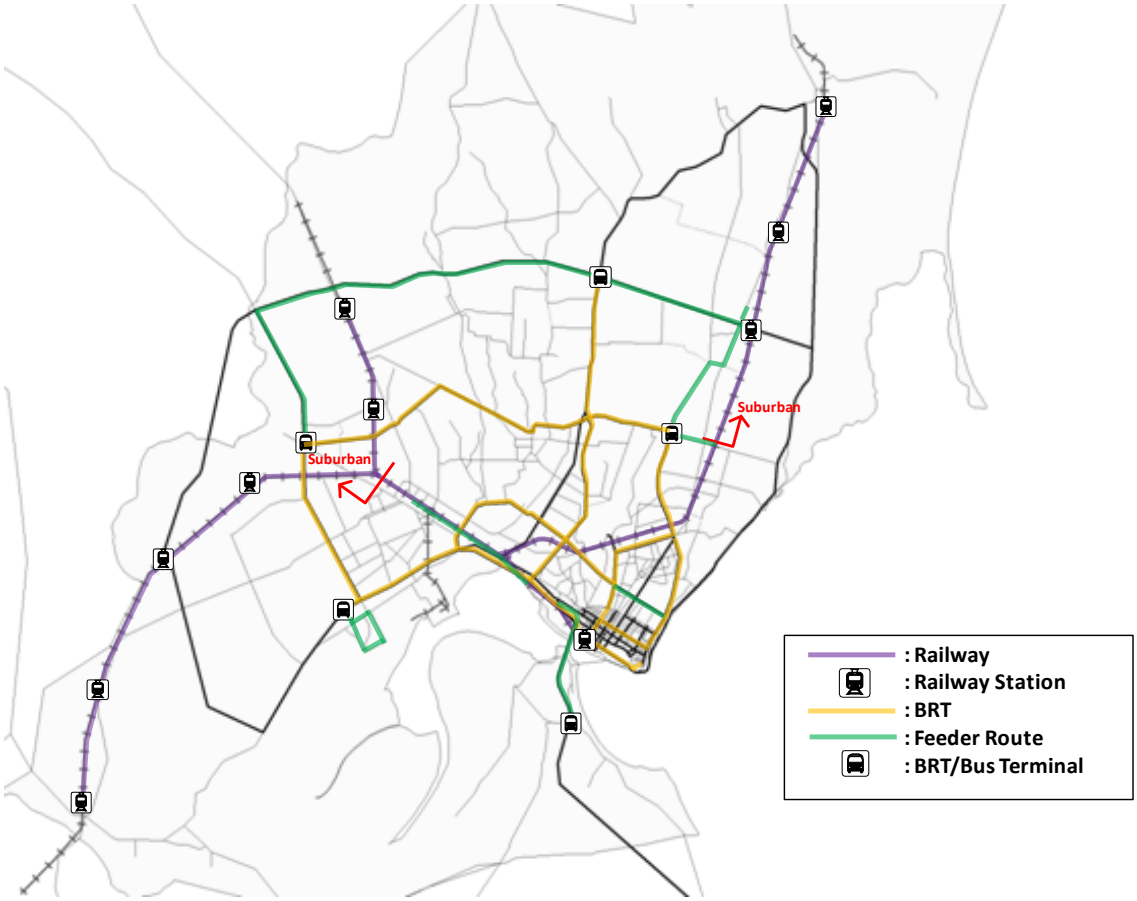
Phase 2 covers the medium term (to 2025; see Figure F.28) and includes the first of three passenger rail routes, the Maputo–Matola Gare Line, and the second phase of BRT development, including the main Matola–Maputo links, with two new options, one via Museu and other along the widened Joaquim Chissano Highway. Each BRT route will depend on one or more integration terminals that will receive the associated feeder routes.



Source: JICA Project Team

Figure F.28: Proposed Mass Transit Network for 2025

Phase 3 covers the long term (to 2035; see Figure F.29) and encompasses the complete mass transit network proposed for 2035 including all of the second and third rail lines (i.e., Maputo-Marracuene and Machava–Boane), and also the completion of the BRT system including extensions to the network (e.g., extension to Katembe via the new bridge).



Source: JICA Project Team

Figure F.29: Proposed Mass Transit System for 2035