EXECUTIVE SUMMARY

1. STUDY AREA

Nairobi Metropolitan Region (NMR), extends over 32,000 sq. km and is located in the South Central Part of the country. It includes the districts of Nairobi, Kiambu, Thika, Machakos and Kajiado and the County Governments of Nairobi, Kiambu, Machakos and Kajiado as per the new constitution. The NMR occupies 5.5 percent of the country's area and has 23 percent of the country's population.

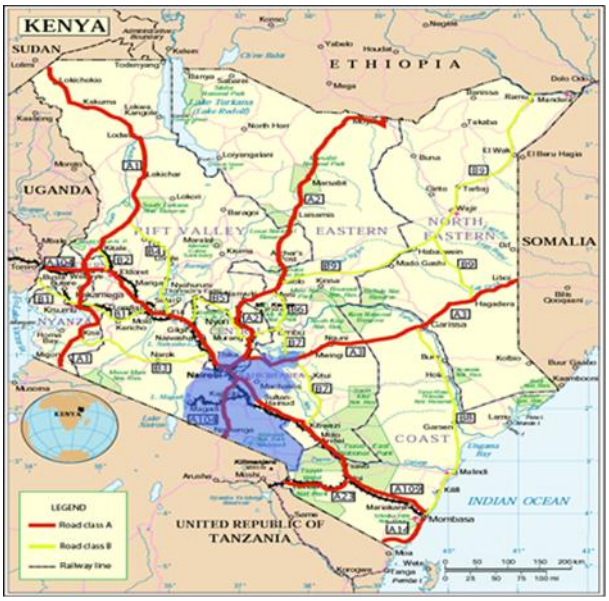


Fig 1. Study area

2. STUDY OBJECTIVES

This study had three main objectives:

1. Assist the Government of Kenya (GOK) in preparing a coherent public transport policy framework for NMR; make recommendations for legal ,regulatory and institutional framework for operationalizing the policy;
2. Carry out a pre-investment study of various options of mass transit systems (e.g. Heavy Rail Transit, Light Rail Transit Bus Rapid Transit, etc.) for the Nairobi Metropolitan Region.
3. Provide technical assistance to the Ministry of Transport to review the detailed engineering design reports and bid process management.

3. NMR PROFILE

NMR extends from the eastern edge of the Rift Valley where the elevation is 2,300m above sea level and gradually slopes down towards the east and the south to an altitude of 1,400m above mean sea level. The western and northern part of NMR has hilly terrain, while the eastern part of NMR consists of gentle slopes

The social-cultural areas of these districts are diverse where the urbanised areas have multi-ethnic groupings and rural has homogeneous ethnic groups including Kamba on the eastern province, Kikuyu in central province, Maasai in the Rift Valley.

Economically, the eastern, though dry and central provinces of the project area are dominated by crop growing while the rift valley mainly engage in pastoralist. Poverty is high in Kajiado followed by Machakos and then Kiambu/Thika districts in line with economic potentiality of the areas.

The total population of the NMR is estimated to have increased from 4.85 million in 1999 to 6.7 million in 2009 at an average annual growth rate of 3.3%. The population share of the NMR to the total population in Kenya is estimated to have increased from 16.9% in 1999 to 23% in 2010.

District	TC/MC/CC	Area (sq.km.)	Enumerated Population			Population Density (persons per sq. km)	
			1999	2009	CAGR*	1999	2009
Nairobi	City Council	**696**	**2,143,254**	**3,138,369**	**3.92%**	**3,079**	**4,509**
Kiambu		**1,324**	**744,010**	**922,370**	**2.20%**	**562**	**697**
	Kikuyu TC	**137**	156,131			1,140	
	Karuri TC	**46**	71,475			1,540	
	Limuru MC	**156**	68,326			439	
	Kiambu MC	**98**	60,605			618	
	Kiambu CC	**887**	387,473			437	
Thika		**1,960**	**645,713**	**864,509**	**2.94%**	**329**	**441**
	Ruiru MC	**291**	109,574			377	
	Thika MC	**94**	106,707			1,141	
	Thika CC	**1,576**	429,432			272	
Kajiado		**21,903**	**406,054**	**687,312**	**5.43%**	**19**	**31**
	Kajiado TC	**288**	9,165			32	
	Olkejuado CC	**21,615**	396,889			18	
Machakos		**6,281**	**906,644**	**1,098,584**	**1.85%**	**144**	**175**
	Machakos MC	**349**	143,274			410	
	Mavoko MC	**957**	27,168			28	
	Kangundo TC	**178**	179,952			1,010	
	Masaku CC	**4,797**	556,250			116	
NMR		**32,164**	**4,845,675**	**6,711,144**	**3.31%**	**151**	**207**
Kenya		**581,677**	**28,686,607**	**40,406,412**	**3.16%**	**49**	**69**

Nairobi city spread over 696 sq. km occupies about 2% of NMR area but accommodated an estimated 3.13 million people in 2009. This is nearly 47% of the NMR population. Nairobi City is estimated to have an average population density of 4509 persons per sq.km. As compared to this, the population density in the Town Councils of Kikuyu, Karuri, Thika and Kangundo is around 1000-1500 persons per sq.km. The population density in the Municipal Council of Limuru, Kiambu, Ruiru and Machakos is in the range of 400-600 persons per sq.km. Population density in the County Councils range between a low of 18 persons per sq.km in Kajiado to about 437 persons per sq.km in Kiambu.

Nairobi contributes significantly to the national GDP. 75% of national GDP is contributed by the manufacturing and services sector which are mainly urban based activities. Nairobi is a major location for these sectors and hence plays a major role in the economic growth of the country.

Formal employment in the major towns of NMR in 2007 accounted for 25.1% of the total wage employment in Kenya. Nairobi city accounts for nearly 90% of the formal employment in NMR. Average annual growth of formal employment in Nairobi and other towns in NMR from 1999 to 2007 is in the range of 2.6 to 2.8 percent.

It is estimated that the informal employment is more than 3 times the formal employment. As per Kenya National Bureau of Statistics, the estimated informal employment growth in Nairobi Province, was 6.92% per annum between 2004 to 2008.

Rate of increase of motor cars in Kenya is about 7.0% per annum and is significantly higher than the rate of growth of population. During the same period, public transport vehicles such as buses and mini buses have registered a growth of about 5% per annum.

4. NMR DEVELOPMENT POLICIES AND GUIDELINES

NMR development policies are stated in several Government reports. For example;

- The 'Kenya Vision 2030' aims at achieving a sustained GDP growth of 10% up to 2030.
- The vision of the Integrated National Transport Policy is to have "A world class transport system that is integrated and responsive to the needs of people and industry".
- Nairobi Metro 2030 vision for NMR is to be a World class African Metropolis
- Nairobi Urban Transport Master Plan emphasises the need for a good road network system along with an efficient public transport system.

5. NMR PUBLIC TRANSPORT SYSTEM

Present Public transport in NMR is dominated by Matatus. An estimated 16,000 vehicles operate in NMR. Today, the Matatu service is the backbone of public mass transport services in NMR. It is estimated that the matatus carry about 33% of the urban commuter traffic which amounts to about 3 million passengers per day. Buses operate on about 67 routes and are estimated to carry about 0.35 to 0.40 million passengers per day which is about 4% of all passenger trips in NMR. Most bus companies operate on the same routes as the Matatus and compete for the same traffic.

Among the intermediate public transport (IPT) services, Taxis are a popular mode both for tourists and locals. TukTuks are 3-wheeler motor vehicles which also operate as an IPT. There are about 200 tuktuks operating on similar lines to taxis but catering for shorter trips. 2-wheeler motor cycles are operated as IPT service under the name boda bodas. Their operational area is primarily from and to the municipal towns. Similarly, Cycle taxis also operate as IPT in rural areas.

Kenya Railway presently provides skeletal inter-city services from Nairobi Railway Station to (i) Embakasi Village (12.6 km), (ii) Kikuyu (31 km), (iii) Kahawa (24 km), and, (iv) Ruiru (32km), with only one trip each way per day. The average speeds range from 12 to 20 kmph. Though a more economical mode of public transport, most urban commuters do not use the commuter rail due to: lack of safety, lack of comfort, limited number of routes and services, inadequate inter-modal transfer facilities and long walk between station and places of work.

Nairobi, the Capital City of Kenya, is a major air transport hub for Eastern Africa. Currently, Nairobi is served by two airports namely: Jomo Kenyatta International Airport (JKIA), which handles medium

and large aircrafts operating on international and national routes and the Wilson Airport on Langata Road, which essentially handles small aircrafts operating on the national and regional routes

With the continued growth in the air passenger traffic, the two airports are reported to be reaching their capacity. There is a need for expansion and development of the airports as major hubs on the continent.

6. NMR DEVELOPMENT SCENARIOS

In the context of this study, a scenario analysis was done to project the future economic activity, their location and the resulting population distribution in NMR.

6.1 Employment Growth Options

Scenario	Basis	Value
LOW	Past Growth Rate in NMR	2.6% per annum (past trend)
HIGH	Desired Growth Rate in NMR	4% per annum up to 2050 (Vision 2030 target)

6.2 Employment Distribution Options

Scenario	Description
Nairobi-Centric	▪ 75% of new employment located in Nairobi and ▪ 25 % of new employment located in OMR
Multi-Centric	▪ 35% of new employment located in Nairobi and ▪ 65 % of new employment located in OMR

6.3 Population Forecast

Population growth options

Scenario	Basis	Value
BAU	Past Growth Rate in Nairobi	4.0 % per annum
High	Higher Growth Rate in OMR	6.0 % per annum

Projected Population based on Population Growth Scenarios

Sub-region	Factor	Year			
		2030		2050	
		BAU	High	BAU	High
Nairobi	Pop. ('000)	7,008	9,243	15,064	23,199
	% of NMR	47%	42%	47%	37%
OMR	Pop. ('000)	7,979	12,646	17,149	38,953
	% of NMR	53%	58%	53%	63%
NMR	Pop. ('000)	14,987	21,889	32,213	62,152

7. TRAVEL DEMAND FORECAST

To assess the travel demand within the NMR, the study area was delineated into 74 traffic analysis zones (TAZ). A four stage urban transport planning model was used to simulate the travel demand pattern between TAZs in NMR. Future travel demand forecasts for 2030 on the selected MRTS corridors for low growth scenarios are as follows;

Average Daily Corridor Loading in 2030 (BAU Growth) - Nairobi Centric

Corridor Name	Total Loading	Max. Section Load	Ave. Section Load	Ave. Trip Length (km)
Waiyaki Way	346593	210868	151314	7.89
Juja Road	525157	417577	251137	10.52
Jogoo Road	424680	283617	244833	7.71
Limuru Road	167879	119849	91633	9.34
Thika Road	557064	343702	239460	8.66
Langata Road	236733	168245	68685	3.79
Ngong Road	369539	251518	157313	5.55
Mombasa Road	237195	145175	96910	13.04
Outer Ring Road	364241	208518	194515	6.67

Average Daily Corridor Loading in 2030 (BAU Growth) - Multi Centric

Corridor Name	Total Loading	Max. Section Load	Ave. Section Load	Ave. Trip Length
Waiyaki Way	326965	164387	135040	10.92
Juja Road	643151	424057	312219	11.71
Jogoo Road	357223	227741	198442	8.21
Limuru Road	199465	135777	114315	11.64
Thika Road	712292	430861	314941	11.65
Langata Road	162961	84598	66892	8.02
Ngong Road	572593	396311	293063	11.45
Mombasa Road	567931	300230	228896	13.53
Outer Ring Road	281886	194247	173238	10.57

8. PROPOSED NMR MULTIMODAL TRANSPORT PLAN

4 major types of movements take place within the NMR namely International/National, Intra-Regional, Intra-city/town and Intra-CBD. Presently all these movements share the same transport links, get mixed together, conflict with each other creating a whole range of problems especially congestion and safety. The main objectives of the multimodal transport plan for NMR are to:

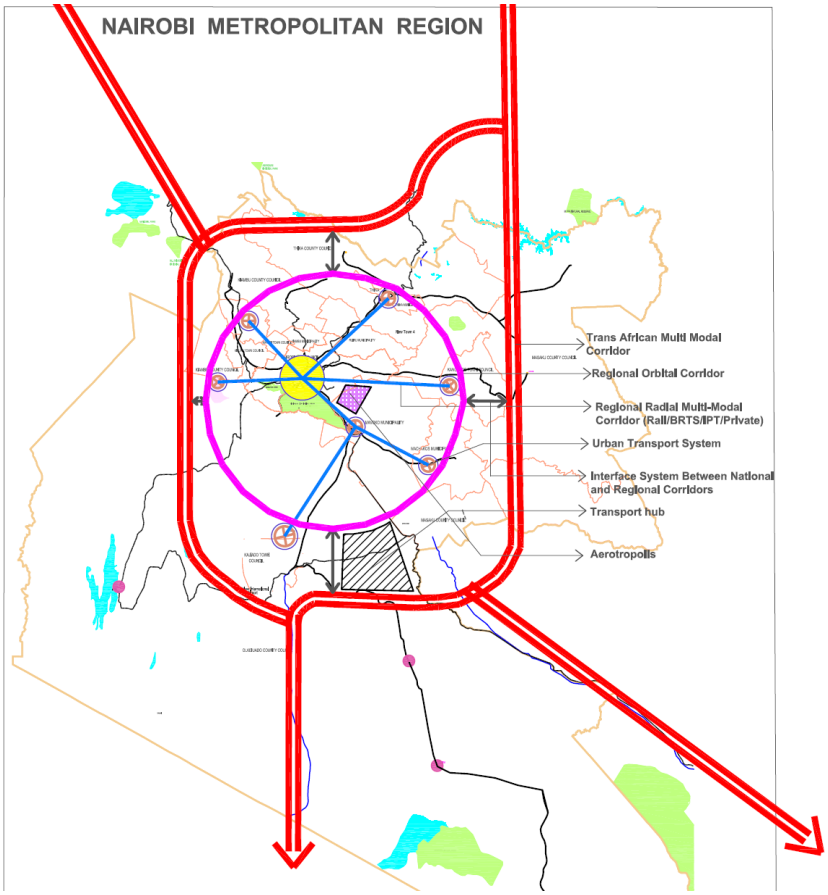
- improve accessibility of and connectivity amongst activity /locales
- increase availability (density) and capacity
- reduce circuitry
- increase redundancy
- spatially segregate different movement types
- improve level of service (speed, safety, etc)
- distribute traffic by links, modes and time
- establish a hierarchical network system

8.1 Regional Transport Network

The Conceptual Regional Transport System in NMR addressing the stated objectives is as shown in the figure below and includes:

- A Regional Grid at the outer edge of the region, forming part of the national road and rail system and Trans-African transport corridors. The Regional Grid would be a multi-modal corridor. Goods movement will be predominant along this grid.

- A Regional Orbital directly inter-connecting the regional urban centres and promoting direct accessibility and flow amongst them without the necessity to pass through Nairobi city. Both passenger and goods movement, equal in proportion, would take place along the regional orbital.
- A number of radial corridors, of road and rail, between Nairobi and each of the regional towns. These multi-modal corridors will enable flows between Nairobi and the regional town at a high level of service. Passenger movement, in particular by public transport would be predominant along the radials. Public transport modes including rail based systems and high occupancy vehicles have priority along these radials.



Multi modal transport development plan for NMR

8.2 Nairobi Transport Network

Similarly, the Nairobi City transport system should include both a road and rail based transport system and services.

Road Network should comprise of orbital and radial corridors. The CBD Orbital sould be upgraded to 6/8 lane dual carriageway with exclusive BRTS lanes, pedestrian footpaths, service roads, off street parking facilities, etc. The Nairobi City Orbital should include the Northern by pass, Eastern by pass, and the Southern by pass in continuity. A new Intermediate Orbital Corridor in the middle area of the city in between the CBD Orbital and City Orbital should be developed with a road reserve of 60-100 meter.

The 9 Radial Roads in the city should be upgraded to 4/6/8 lane dual carriageway with exclusive High Occupancy Vehicle (HOV) lanes for BRTS and other high occupancy vehicles; with service roads; with paved shoulders; with adequate footpaths and safe crossing facilities. All the roads identified for up-gradation/new construction/missing links, in the short term (2010) and medium term (2015) phases, in NUTRANS Master Plan is reiterated and should be developed.

Kenyan Railways is planning to upgrade its railway system to about 1400 km length of standard gauge with high operating speeds of 120 kmph and with the ability to carry heavy loads (4000 tonnes) per rake. It has been proposed that this railway system, within NMR be re-aligned along the proposed regional bypass grid. This will be in the interest of the region and the railways.

8.3 ALTERNATIVE MRTS NETWORK: CONCEPT, EVALUATION & SELECTION

On conceptualization of development scenario and multi-modal transport system for NMR, the need for an effective MRTS, particularly along the major radial corridors, has been established. A spectrum of choice of public transport technologies is available with each technology offering certain potential capacities, costs and constraints. In the first instance the potential of operating commuter rail service along the existing rail lines in the NMR has been examined and found that it can cater only a small share of the potential travel demand. While it is included in the final recommendation, it is excluded in evaluating the alternatives. Five (5) alternate network system (technologies) along the major road corridors have been conceptualized. They are: 1) BRTS, at grade, with intersection improvements and signal control; 2) BRTS, at grade, with flyovers (for BRTS only) at intersections; 3) BRTS, elevated; 4) LRTS, elevated; and 5) a mix of LRTS and BRTS with LRTS elevated and BRTS at grade with flyovers at intersections. The MRTS is supported by General Public Transport (Buses and Matatus in mixed traffic). The modal share and loadings; in the links of the system, under each concept has been derived from the Transport Model. Multi-criteria analysis has been adopted for evaluation of the alternatives. The criteria include: modal share, passenger trips, passenger hours, vehicle-kms, vehicle hours, EIRR, energy consumption and environmental impact interms of production of GHG. Scores for each system under each criteria have been derived, on a scale of 10 to 0, based on the objective of maximizing or minimizing the output values of the criteria. The alternatives have been ranked based on the sum of scores. LRTS, elevated, ranks first and BRTS elevated, second. Mixed (LRTS & BRTS) system stands a close third. On considerations of traffic demand, costs and others, the mixed system has been selected for further detailing.

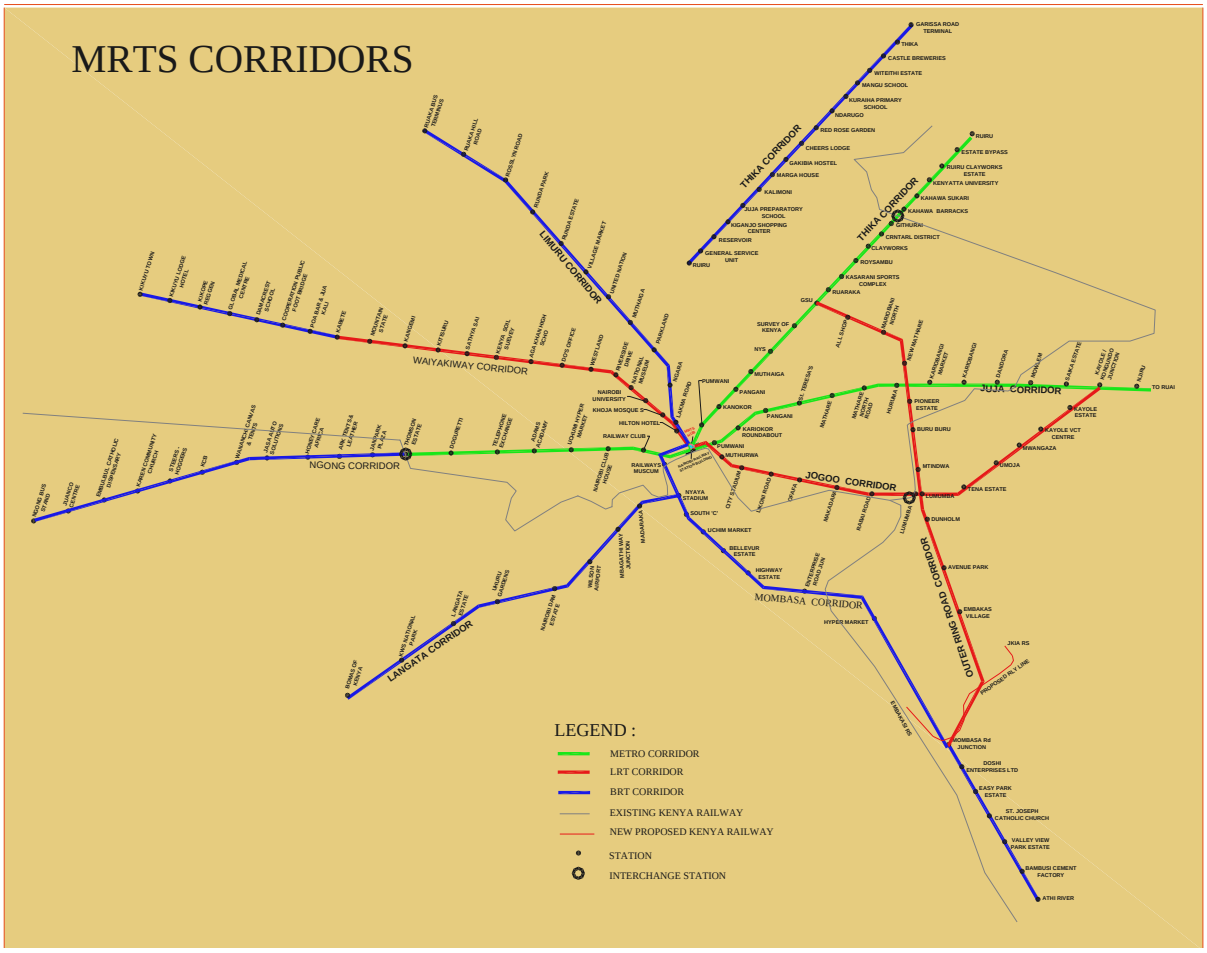
8.4 MRTS Corridors

Appropriate mass rapid transport system needs to be considered along the 9 road corridors leading to the CBD of Nairobi. These corridors are:

- Nairobi Railway Station (NRS) – Ruiru-Thika
- NRS – Juja Road – Kangundo
- NRS – Jogoo Road - Komorock
- NRS – JK Airport- Athi River
- NRS – Langata Road – Karen
- NRS – Upperhill - Ngong
- NRS – Kabete – Kikuyu
- NRS – Gigiri – Limuru
- Outer Ring Road

8.5 Choice of MRTS Technology

The transport demand forecast suggests that the high capacity Metro rail would be required on some corridors in NMR. Medium capacity modes such as Bus Rapid Transit System (BRTS), Light Rail Transit System (LRT) and Monorail will be adequate on others. The choice between these systems depends mainly on demand level represented by the peak hour peak direction traffic (PHPDT). Corridors having a PHPDT of less than 5000 passengers have not been considered for a new MRTS technology. BRTS or Monorail has been considered where the PHPDT is in excess of 5000 passengers. Between these two, the BRTS has been considered as the more appropriate for Nairobi as it would allow up gradation into a higher capacity system without much inconvenience. LRT has been considered where the PHPDT is in excess of 12,000 passengers and the Metro Rail in corridors where the PHPDT is in excess of 30,000. The suggested network of BRTS and Metro/LRTS on the 9 corridors of Nairobi is shown in the figure below:



8.6 Multi Modal Integration

Multimodal Integration would include physical, operational (including technology), monetary (including fare policy), fiscal, legal and institutional aspects at various levels to deal with:

- land use and transport system of the region and the city/town
- national and regional transport systems

- regional and city/town transport systems
- different transport modes of city system

The present Nairobi Railway Station area, including the yards, is proposed to be developed as the Central Hub Terminal of Nairobi Mass Rapid Transit System (MRTS). All lines would originate/ terminate at this terminal or traverse through this terminal. This would enable easy transfer amongst the lines facilitating the long trips from one point of the region/city to the other.

View of proposed Central Transit Hub

8.7 Demand Management

There is a limit to supply of transport services. Therefore it is proposed that the public transport system supply is accompanied by effective demand management measures. Transit oriented development around rail stations, road terminals and along the corridors/lines up to one km on either side will help and is proposed.

It is further proposed that a Transport System Management Plan (TSMP) is prepared to support the public transport system in critical areas like CBD, proposed District Centers, Nodal Terminals, MRTS/BRTS stations/stops and all along the proposed MRTS corridors. TSMPs has to be prepared for the construction stage of MRTS and later for the operation stage on a continuous basis.

9. BUS RAPID TRANSIT SYSTEM FOR NMR

BRTS has been proposed along three corridors as shown in figure above. Salient features of BRTS are as follows;

- Initially, 12 meter long standard bus size is proposed to meet the average peak hour demand. As demand increases, single articulated buses of 18 meter length could be introduced. Buses will be both ordinary and deluxe. Deluxe services would cater to the requirement of commuters with higher paying capacity.
- Bus operations are characterized by frequent stops and starts with a dwell time of 30-45 seconds at stations and the operational headways of 15-120 seconds—proposed headway being 30 - 60 seconds. A high horse power engine meeting Euro –IV norms is proposed.
- Diesel & ULSD are the selected fuels. CNG fuelled buses may be considered for future
- Buses with floor height of 400 mm for up to nearly sixty percent of bus floor length are recommended with two doors of 1200mm width each.
- BRTS operation would be a closed system with trunk and feeder service pattern.

- At-grade stops are located near intersections where pedestrians have the benefit of utilizing the pedestrian crossing normally provided at those intersections.
- BRTS is proposed to be mostly at-grade except within the CBD where it would be elevated. It would generally be placed at the road median. Opposing bus stops would be staggered and a passing lane would be provided at such places to facilitate overtaking. Bus stops would be located on the kerb side.
- Bus stops are proposed to be positioned at an average distance of about 750 meters.
- Rigid pavement (concrete) is proposed for at-grade and elevated busways.
- ITS will be used to control and manage the BRTS operation
- BRTS fleet requirements are estimated to be 378, 461 and 630 buses in the years 2015, 2020 and 2030 respectively.
- The total cost of BRTS system inclusive of capital costs for infrastructure, fleet, ITS on the 3 corridors is estimated to be KSH 53.55 billion.
- The annual operating cost at breakeven point of all the BRTS corridors is estimated to be KSH 1.9 /km.
- Fare level needs to be between 2 and 2.5 KSH per passenger kilometer to ensure full recovery of Operations and Maintenance costs.
- Existing regulation prohibiting standees in Public Transport Systems is suggested to be amended to allow standee passengers in BRTS.

For efficient management of the BRTS in NMR a special purpose vehicle (NMR BRT Company) may be constituted by the Government of Kenya. GOK may contribute 51% equity and the remaining by other concerned agencies, private entities, etc. Initially the GoK may contribute an equity equivalent of 100 million Ksh as the share of the government.

10. RAIL TRANSIT SYSTEM FOR NMR

Metro/LRT has been proposed on 6 corridors as shown in the figure above. Salient features of the proposed Metro/LRT system are;

- Entire Metro/LRT network is proposed to be on elevated viaducts except maintenance yards and depots and end sections which will be at-grade.
- LRT at grade is not recommended on account of non-availability of road space in CBD area, the limitation of headways less than 5 minutes limiting the capacity to 12000 phpdt, lower average speeds due to signalized (even priority signaling) at road crossings and need for fencing throughout the corridor amongst several other factors.
- The corridors generally follow the central verge of the roads. The overall length of the largely elevated Metro and LRT corridors is 90 km. Underground construction is limited to 3 km. It has 76 stations and 5 maintenance and stabling depots.
- Twin 2.65m wide and 43m long coach units each with 64 seated passengers and 361 standees, totaling to 425 is proposed for LRT and for the Metro 4 coaches of 3.2m wide and 20m length each carrying capacity of 310 passengers
- A LRT train consisting of two modules of 43m with a capacity of 850 passengers operating at headway of up to 2 minutes, the system capacity will be 25,500 phpdt. A metro train can be gradually increased up to 8 coaches per train with a capacity of 50,000 phpdt at 3 minutes headway.

- Metro/LRT shall operate with electric traction that will keep pollution level low. From operational and aesthetics point of view it is recommended to adopt 750 V DC traction through 3rd rail.
- The power requirement of the Metro/ LRT system works out to 2 MVA per km
- The entire scheme of power supply, traction and auxiliary supply shall be monitored and controlled from a centralized Operations Control Centre (OCC) being provided at Maintenance Depot.
- A signalling and control system will be provided on all running tracks of the LRT network including car shed to ensure safety.
- A computer based automatic fare collection (AFC) system is proposed. AFC system proves to be cheaper than manual system in long run due to reduced manpower cost for ticketing staff.
- Common Smart Card based ticketing for both Suburban and Bus systems is not proposed at this stage as this will require installation of AFC system at all rail suburban stations and in buses and a Clearing House system. It will be possible in future.
- Train services will operate for 19 hours of the day (5 AM to Midnight) at a journey speed of about 35 kmph. The period between 00.00 hrs. to 5.00 hrs. is reserved for maintenance.

Infrastructure comprising of stations, viaducts, tunnels, central hub, depot for stabling of rolling stock, maintenance facilities, OCC, SCADA, administrative building, space for systems, traffic integration measures, EMP and R&R works etc is included.

Elevated stations with side platforms are to be designed for train length of three modules each of 43m length to cater for future traffic. Station design will keep in view the provisions of NFPA 130 and adequate provisions will be made for lifts/escalators/ staircases. At-grade stations will be in the middle of the road. Off road at-grade stations will be located where land is available. The access to the station is through the unpaid concourse, placed at the ground level, where Ticket Counters will be provided. Underground Stations will have a central platform.

Additional land is mainly required for Metro/LRT structures, station building, platforms, entry/exit structures, roadside traffic integration facilities, traction sub-stations/ auxiliary sub station, generator room, pump house, temporary construction depots and work sites. Land for depot and parking depot is designed to cater to parking of rolling stock at lean traffic hours, scheduled inspections, periodic overhaul, OCC, training facilities, daily cleaning and periodic washing of coaches etc.

11. SOCIAL AND ENVIRONMENTAL ASSESSMENT

Technically, all the MRTS corridors have more than 30 meter road reserve. This is generally adequate for providing the elevated LRT structures at the center of the road. However, additional land would be required during construction phase and at stations, depots and yards. The exact requirements would have to be worked out during the detailed engineering studies which are to follow.

Water samples were tested at 8 locations. It is noted that there are notable suspended solids in the rivers within the city limits but reduces outwards in the outlying districts for the same corridor. Oil and grease in all the rivers samples is notable with as high as 0.235mg/l in some streams as opposed to the required guideline of nil under the Water Quality Regulation. Water in all the rivers, however, was found to have low dissolved solids and neutral. An intensive water quality monitoring on

parameters associated with transportation activities would be necessary. The high capacity MRTS is expected to reduce the rate of increase of oil and grease in the rivers due to a reduction in the number of public transport vehicles operating on the major corridors.

Based on physical observations on air quality, there is low level of major emissions, namely Sulphur Oxides, Nitrogen Oxides, and carbon monoxide. Carbon dioxide and particulate matter (most common parameters) are also relatively low particularly outside the city limits. According to the current regulations on noise and vibrations, all the stations selected for noise measurements showed elevated noise levels up to 40m from the major road corridors.

12. PROJECT CAPITAL COST

The infrastructure cost estimate is based on cost of similar works in the ongoing Thika Road Improvement Project. Cost of BRT/LRT systems/Rolling stock is based on experience in similar projects carried out in India. Cost of Govt. land is assumed to be nil. Social Impact and R&R is taken as 1% of civil cost. The capital cost estimate of all the corridors at 2010-11 prices is summarized below:

Corridor	Financial Cost (mill Kshs)	Economic Cost (mill Kshs)
MRTS 1 : Waiyaki Way	54,864	45,770
MRTS 2 : Thika Road	108,115	89,361
MRTS 3 : Juja Road	63,207	52,414
MRTS 4 : Jogoo Road	43,183	35,938
MRTS 5 : Outer Ring Road	42,021	34,953
MRTS 6 : Ngong Road	44,411	37,364
MRTS 7 : Limuru Road	17,357	15,100
MRTS 8 : Langata Road	9,120	7,934
MRTS 9 : Mombasa Road /Athi River	27,075	23,555

12.1 Operation and Maintenance Costs

Operation and maintenance costs for BRTS have been estimated to be about KSH 80 per vehicle kilometer. In addition, the maintenance of infrastructure is taken to be 0.5% of the capital cost. BRTS vehicles would require replacement after an operating life of 10 years.

Operation and Maintenance costs of LRT include Staff costs, Maintenance cost towards upkeep and maintenance of the system and consumables and Energy costs (Power Supply). There will be a need of replacement after 20 years in the systems of signaling and electrical. The replacement cost in the system of signaling is assumed to be 10% of the total signaling system cost at 2010-11 prices. The replacement cost in the system of electrical is assumed to be 20% of the total electrical system cost.

The maintenance cost of the system has been estimated @ 2% of the construction cost per year. All costs have been converted into economic costs by applying the standard conversion factor of 0.87.

13. ECONOMIC ANALYSIS

13.1 Benefits

Economic benefits are calculated as the difference in the 'without' and 'with' project cases. The 'without project' situation is defined as the 'base' case or the 'do-nothing' case, where the projected development scenario is imposed on the existing transport network. The 'with project' case represents the future development scenario on the integrated multi-modal transport network after the MRTS project is implemented.

The benefits of the MRTS project would be in terms of savings in travel time cost and vehicle operating cost, and reduction in carbon emissions. Estimation of the value of time (VOT) for passengers was based on the wage rate approach. The monthly income of passengers was determined from the Stated Preference Survey carried out by the Consultants for PT users. Reduction in carbon emissions was estimated with the help of a software model for analysing carbon footprints.

13.2 Economic Viability

The annual cost and benefit streams for each MRTS corridor were analysed to derive the net cash flows. The EIRR and NPV @ 12% discount rate were determined using the discounted cash-flow technique. The results of the economic evaluation are summarized in table below.

Corridor	EIRR (%)	NPV @ 12% (mill Ksh)
MRTS 1 : Waiyaki Way	11.09%	(-)2,255
MRTS 2 : Thika Road	25.52%	97,057
MRTS 3 : Juja Road	16.53%	17,598
MRTS 4 : Jogoo Road	19.80%	18,654
MRTS 5 : Outer Ring Road	20.81%	22,198
MRTS 6 : Ngong Road	18.99%	18,431
MRTS 7 : Limuru Road	22.31%	8,537
MRTS 8 : Langata Road	28.98%	6,775
MRTS 9 : Mombasa Road /Athi River	14.23%	2,598
All Corridors together	19.98%	189,592

The rate of return considered desirable for transport infrastructure projects is 12 percent as the opportunity cost of capital is 12%. The results indicate that all the corridors, except Waiyaki Way, are

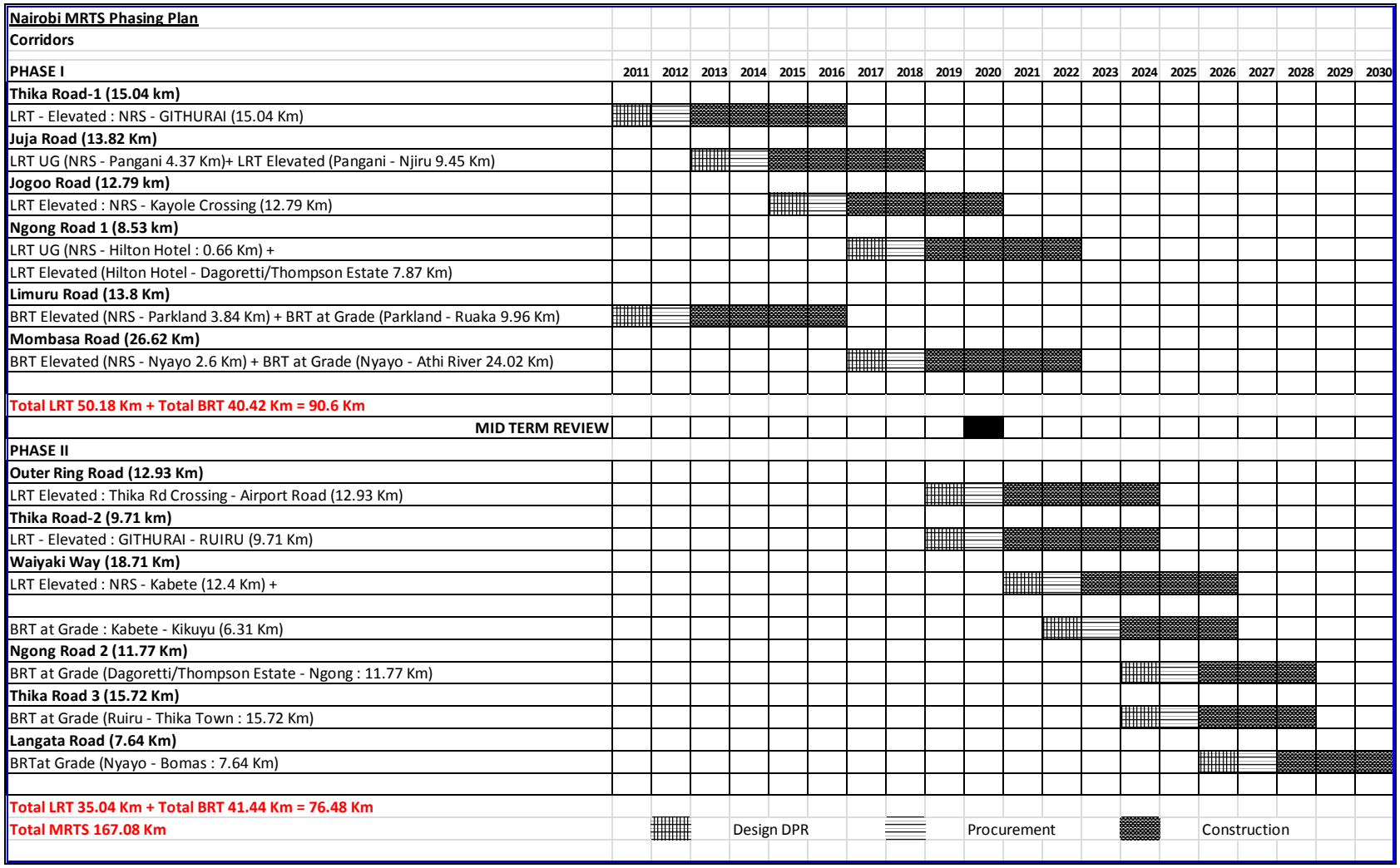
economically viable, as the EIRRs are greater than 12 percent. BRT corridors have higher EIRRs because of their relatively lower costs vis-à-vis LRT costs.

14 PHASING PLAN

The implementation is proposed in two phases. Phase 1 includes corridors on which construction can be initiated in the next 10 years. The remaining corridors could be taken up for implementation in Phase 2. The sequence of implementation in the two phases is shown in the chart below.

Nairobi MRTS Phasing Plan

Corridors



15 FINANCIAL VIABILITY

15.1 Revenue estimate

The Financial Internal Rate of Return (FIRR) is estimated using discounted cash flow analysis. Capital and operating cost are as mentioned earlier. Revenue is estimated based on the average daily ridership on each route. This analysis assumes a fare of KSH 2.5 for BRTS and KSH 4 per passenger-kilometer of travel on LRTS. Other revenue includes advertisements and property sale and lease at depots of the system, at terminus, etc. As has been observed in many operational MRTS, the estimated revenue from advertisements and space rentals is around 12% of the fare box revenue. The same has been assumed here as well. Other possible sources of revenue such as sale of land/built-up space, parking fees at terminals etc have not been included in the analysis.

15.2 Financial Viability

The MRTS project is proposed to be funded as a Public Private Partnership (PPP) by leveraging resources and core competencies of the private sector. The government would have to play a key role in building confidence amongst the public and the partners.

The commercial viability of the Phase 1 MRTS sections was estimated, both in terms of Project FIRR and Equity FIRR. The Project FIRRs, or the returns on the total investment, were found to be lower than the EIRRs, as is commonly the case with such projects. With project financing, through debt and equity, and with infusion of Viability Gap Funding (VGF) the projects could be made viable, with Equity FIRRs of 18%. The total VGF requirement for the Phase 1 sections is to the tune of 227 billion KSH. GOK could raise resources for funding the VGF through a combination of measures such as soft loans from Multilateral Agencies, surpluses from property development, and revenues from new taxes like cess on fuel, surcharge on road and vehicle tax and betterment levy on property tax.

16 RESOURCE MOBILISATION

Considering the quantum of investments required private sector participation (BOT) and tax and fiscal incentives as well as both Equity Contribution and Debt Resources will need to be used. Additional Sources of Resource Mobilization are Real Estate Development, Dedicated Road Fund /Transport Fund (Infrastructure Initiative Fund), Municipal Bonds/Infrastructure Bonds, Sale of Government Land and other Property, Advertising Revenue.

17 LEGAL FRAMEWORK

The existing statutes, enacted as they are many years back, do not address the needs of planning, development, operation and management of modern technologies like BRTS, LRTS, Metro, ITS, etc and also the recent trends of development through PPP route and hence need to be revised.

18 INSTITUTIONAL Reforms

The responsibilities for urban transport present a conflicting and confusing situation. The Kenya Government ministries have National focus. Local authorities, who have direct responsibility, lack in resources and capacity. The private operators, though rendering a great service in enabling mobility of people, are constrained with their limited objectives, limited resources, limited capacity and skills and the day to day problems of survival.

There is a need for reforms and restructuring to establish a sound institutional framework with clearly defined functions and responsibilities at all levels and with a high degree of inter-institutional co-ordination to enable rational development and operation of the total transport system in NMR. The

immediate requirement is to constitute a Nairobi Metropolitan Transport Authority to take on this responsibility. Traffic Engineering and Management Units (TEMUs) are proposed to be established in all local authorities, especially in NCC. It is recommended that a Kenya Urban Transport Fund (KUTF) at the GOK level, be established through the enactment of the Kenya Urban Transport Act and the Nairobi Metropolitan Transport Act. It is further recommended that a Kenya Institute of Transport Management (KITM) be established as the nodal agency in capacity building.

19 PUBLIC TRANSPORT AND POLICY FRAMEWORK

19.1 Integrated Multimodal Transport System

Public transport in NMR and Nairobi city will be multimodal and integrated to meet the growing demand for mobility. This will include the Kenya Railway, present road based modes and new medium and high capacity mass rapid transit modes, all as per the projected future demand level on various routes. Introduction of new modes that may be road or rail based will take time. In the interim therefore the present public transport system in NMR will have to be strengthened through the introduction of full scale regulation of service quality, time of operation, route allotment, fares etc. duly monitored by the authorized agency.

19.2 Kenya Railway

Kenya Railway network will provide services both in the city and the region and will be upgraded to do so. The present Kenya Railway service for commuter traffic is too slow, but it provides a ROW and other facilities which will come in handy and can be upgraded to ensure required level of service. Kenya Railways will plan, construct and operate the necessary facilities.

20 WAY FORWARD

20.1 Interim Measures

In the interim, conventional Bus and Matatu operations on the major corridors should be reorganized to complement each other. A trunk and feeder system of public transport should be planned and implemented with the existing facilities. Only high capacity buses should be permitted to operate on the main corridor while the matatus should operate as feeder services to these high capacity bus services. Existing matatu operators could be encouraged to form co-operatives/associations to interline with the high capacity bus operators on the trunk routes (corridors).

20.2 Legal, Regulatory and Institutional Measures.

Government should take necessary Legal, Regulatory and Institutional steps to reorganise the present services and for enabling the operation of trunk and feeder system of multimodal public transport system in the future. Government will have to invest in transport infrastructure to enable private sector participation. Bus services can then be augmented both in NMR and Nairobi city with the help of private sector.

20.3 Process Project Sanction

The project for MRTS needs an administrative approval and sanction for phased implementation.

20.4 Action Plan to re-organise Public Transport System

This needs to be done through an intensive and effective Traffic Engineering and management to maintain mobility level within city and NMR.

20.5 Project Planning and Implementation

This is required to prepare Detailed Project Report and taking action towards project implementation of identified MRTS project (s).

20.6 Stakeholder Communication Strategy

This is essential to elicit support of and approval of stakeholders through various media and stakeholders consultations.