No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF ROADS AND PUBLIC WORKS
MINISTRY OF LOCAL GOVERNMENT
THE REPUBLIC OF KENYA

THE STUDY
ON
MASTER PLAN
FOR
URBAN TRANSPORT
IN
THE NAIROBI METROPOLITAN AREA
IN
THE REPUBLIC OF KENYA

FINAL REPORT

EXECUTIVE SUMMARY

MARCH 2006

KATAHIRA & ENGINEERS INTERNATIONAL
RECS INTERNATIONAL INC.

SD
JR
06-041

EXCHANGE RATE

August 2006
1 US$ = 75.0 Kenya Shillings
1 US$ = 110.0 Yen
1 Kenya Shilling = 1.50 Yen

PREFACE

In response to a request from the Government of the Republic of Kenya, the Government of Japan decided to conduct “The Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area” and entrusted the Study to Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Tsuneo BEKKI of Katahira & Engineers International in association with RECS International Inc. four times between July 2004 and September 2005. In addition, JICA set up an Advisory Committee headed by Dr. Tetsuro HYODO, Associate Professor, Tokyo University of Marine Science and Technology to advise the Study from specialist and technical points of view.

The team held discussions with the engineers of Ministry of Roads and Public Works and Ministry of Local Government as well as other officials concerned of the Government of Kenya and conducted field surveys, data analysis, Master Plan formulation and Pre-Feasibility Study. Upon returning to Japan, the team prepared this final report to summarize the result of the study.

I hope this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Kenya for their close cooperation extended to the Study.

March 2006

Kazuhisa MATSUOKA,
Vice President
Japan International Cooperation Agency

March 2006

Mr. Kazuhisa MATSUOKA
Vice President
Japan International Cooperation Agency

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report of "The Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area in the Republic of Kenya". The report includes the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the comments made by the Ministry of Roads and Public Works and the authorities concerned of the Government of Kenya.

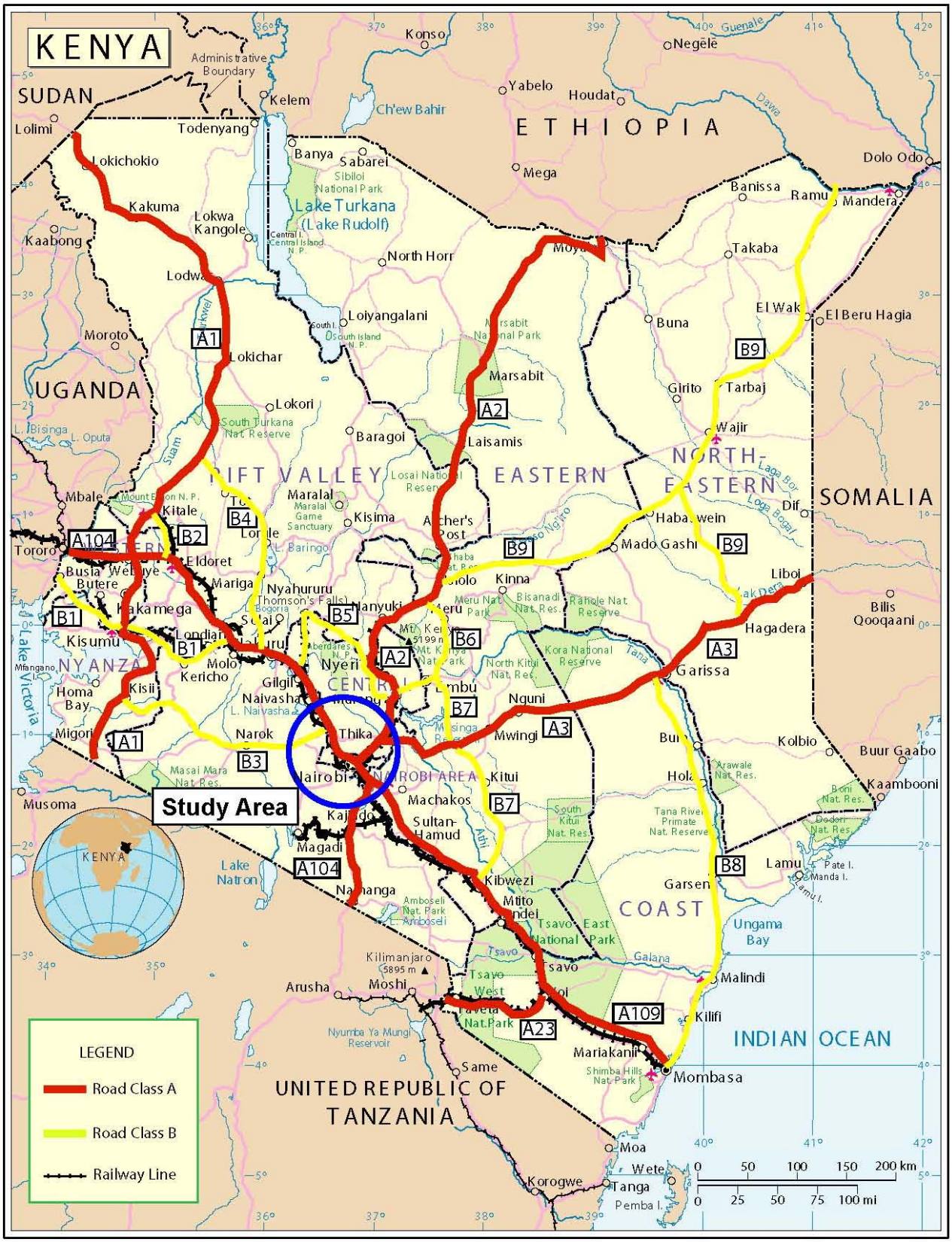
This report analyses the present and future conditions and demand of urban transport in the Nairobi Metropolitan Area. It comprehensively covers the issues of transport including road, public transport, traffic management, institution, legislation, financing and urban environment. The report established an integrated transport Master Plan to the year 2025, including a Short-Term Plan for urgent projects to be implemented in the years 2006 - 2010. The outcome of the Study concludes that the established plans are technically, economically, environmentally and socially feasible and will contribute to the development of the Nairobi Metropolitan Area.

In view of the urgency of development of transport facilities in the Nairobi Metropolitan Area and socio-economic development of the Republic of Kenya, we recommend that the Government of Kenya implement the Projects with high priority.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure and Transport. We also wish to express our deep gratitude to the Ministry of Roads and Public Works, the Ministry of Local Governments and other authorities concerned of the Government of Kenya for the close cooperation and assistance extended to us during the course of the Study.

Very Truly Yours,

Tsuneo BEKKI,
Team Leader
The Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area



Location Map

EXECUTIVE SUMMARY

TABLE OF CONTENTS

SUMMARY

URBAN TRANSPORT MASTER PLAN

Background

The Government of Kenya (GOK) recognizes the transport sector as a facilitator of rapid economic growth, reconstruction, poverty eradication and wealth creation for the country. An efficient transport system is a pre-requisite for the rapid economic development of the country and for improving the quality of life of the people.

The present supply to transport is inadequate to meet the increase in traffic demand, in particular in Nairobi Metropolitan Area. The development of road facilities and traffic management measures are required. The Government of Kenya decided that in order to solve the transport problems, a comprehensive master plan covering the areas of road network improvement, public transport and traffic management should be developed with a time horizon of 2025.

Study Objectives

- To formulate a Master Plan for Urban Transport in the Nairobi Metropolitan Area for the target year 2025,
- To conduct a Pre-Feasibility Study on the priority projects under the Master Plan, and
- To carry out relevant Technology Transfer to Kenyan Counterpart Personnel in the course of the Study.

Plan Components and Project Cost

The Master Plan identifies a number of projects and measures covering the transport sectors of road development, public transport, traffic management and traffic institution, and classified their urgency into short, medium and long term, with the following main components.

- Implementation of previously planned projects
- Formulation of radial and circumferential road network (R/C road networks)
- Enforcement of bus priority policy
- Upgrading of existing rail
- Improvement of Uhuru Highway.

Plan Evaluation

Technical Evaluation

Traffic parameters of average speed and congestion degree on the road networks, both on the city center and the Study Area were used to assess the network efficiency. Low speeds and high congestion degree on "Without Master Plan" case, in which no improvement will be done on the existing transport network, are widely spread when compared with implementing "With Master Plan" case.

Travel Speed and Congestion

		2004 (Base Year)	2010	2025
Study Area				
Average Travel Speed (km/h)	W/O MP(A)	34.1	33.10	31.20
	W/ MP(B)	34.1	37.76	37.40
	BA	1.00	1.14	1.20
Average V/C Ratio	W/O MP(A)	0.501	0.685	0.889
	W/ MP(B)	0.501	0.639	0.741
	BA	1.00	0.93	0.83
City Center				
Average Travel Speed (km/h)	W/O MP(A)	31.0	28.0	25.1
	W/ MP(B)	31.0	34.4	31.8
	BA	1.00	1.23	1.27
Average V/C Ratio	W/O MP(A)	0.809	0.854	0.950
	W/ MP(B)	0.809	0.751	0.850
	BA	1.00	0.88	0.89

Economic Evaluation

Saving in Traffic Cost (MKsh/Day)

Year	2010	2020	2030
Do Nothing	50.171	60.553	85.074
Master Plan	48.252	53.173	73.793
Saving	1.919	7.380	11.281

- B/C ; 2.34
- EIRR ; 39.4%
- NPV ; 10.35 BKsh

Environmental Evaluation

Air Pollution Reduction (Kg/Day/Volume)

		W/O Master Plan	W/ Master Plan	Reduction Amount
2010	HC	3,809	3,671	138
	CO	31,489	30,350	1,139
	NOx	3,719	3,584	135
2025	HC	5,975	5,687	288
	CO	49,399	47,020	2,379
	NOx	5,834	5,553	281

MAJOR COMPONENTS AND COST OF MASTER PLAN (MKSH)

Major Projects		Quantity (km)	Total Cost MKsh	Short Term 2006-2010	Medium Term 2011-2015	Long Term 2016-2025
(1) Road Development						
Bypass and Link Roads	(5 roads)	118.8	7,971	-	-	7,971
Missing Links	(16 roads)	32.8	6,059	3,308	2,751	-
Radial Roads	(8 roads)	203.4	12,400	1,340	2,656	8,404
Circumferential Roads	(3 roads	16.0	1,452	-	892	560
Signalization, NMT, others	(48 signal, 18 NMT)		6,913	1,708	2,843	2,362
Sub Total			34,795	6,356	9,142	19,297
(2) Public Transport						
Bus Incentive/Priority Policy		1 set	2,300	400	200	1,700
Upgrading of Existing Road		1 set	5,800	700	1,400	3,700
(3) Traffic Management		1 set	350	300	50	-
(4) Traffic Institution		1 set	200	200	-	-
Total			43,445	7,956	10,792	24,697

PRE-FEASIBILITY STUDY

Among the projects under the Short Term, the followings are selected for immediate Pre-Feasibility Study. The criterion in selection is urgency and small–scale with low costs, among others. The Plan components and costs are summarized in the table below.

(1) Construction of Missing Links No. 3, No. 6 and No. 7

- Formation of R/C Road Network
- Encouragement of NMT
- Promotion of area development

Technical Evaluation

Travel Speed and Congestion Degree NMA

		2004 (Base Year)	2010	2025
Average Travel Speed	W/O MP(A)	36.5	33.1	31.2
	W/ MP(B)	37.6	33.9	31.9
	B/A	1.03	1.03	1.02
Average VCR Degree	W/O MP(A)	0.501	0.685	0.869
	W/O (B)	0.481	0.664	0.843
	B/A	0.96	0.97	0.97

Economic Evaluation

- B/C ; 5.77
- EIRR ; 40.1%
- NPV ; 2,273 MKsh

(2) Traffic Flow Improvement Plan in the City Center

- Improvement of traffic flow and circulation in the city center, particularly in CBD
- Improvement of traffic flow on major arterials
- Improvement of traffic flow in special commercial area
- Improvement of car parking system inside CBD

Technical Evaluation

Travel Speed and Congestion Degree in City Center

		2004 (Base Year)	2010
Average Travel Speed	W/O MP(A)	31.0	28.0
	W/ MP(B)	32.6	29.1
	B/A	1.05	1.06
Average V/C Degree	W/O MP(A)	0.809	0.854
	W/ MP(B)	0.720	0.752
	B/A	0.89	0.88

Economic Evaluation

- B/C ; 3.49
- EIRR ; 45.8%
- NPV ; 1,851 MKsh

(3) Improvement of Bus/Matatu Transport system

- Restructuring of public transport system, particularly rerouting of Bus/Matatu Routes
- Introduction of Shuttle Bus.

Technical Evaluation

Bus Matatu Travel Speed in NMA

		2004 (Base Year)	2010	2025
Average Travel Speed	W/O MP(A)	30.2	23.2	12.9
	W/ MP(B)	30.5	23.4	13.0
	B/A	1.01	1.01	1.01

Economic Evaluation for Shuttle Bus Project

- B/C ; 1.44
- EIRR ; 25.4%
- NPV ; 771 MKsh

MAJOR COMPONENTS AND COST OF URGENT PROJECTS (MKSH)

	Quantity (km)	Total Cost MKsh	2006	2007	2008	2009	2010	Recommend Implementation Method
(1) Missing Links No.3, 6, and 7		999	9	274	477	239		Foreign Fund
Sub Total		999	9	274	477	239		
(2) Traffic Flow Improvement Plan in City Centre								
- Road connecting to CBD	8.2	390	132	120	138			MRPW
- Traffic Flow Improvement in CBD (NR)	3.1	80	80					MRPW: National Roads
- Traffic Flow Improvement in CBD (CR)	6.0	469	110	24	175	160		CCN: City Roads
- Revitalization of Moi Avenue	0.7	84		84				CCN
- Traffic Flow Improvement in Westlands	0.4	29	29					CCN
- Parking Improvement inside CBD	LS	150	75	75				PPP
Sub Total		1,202	426	303	313	160		
(3) Improvement of Bus/Matatu System								
- Shuttle Bus	1 set	1,203	53	425	425	150	150	PPP
- Corridor Improvement	1 set	44	14	15	15			CCN
- Mode Interchange area Improvement	1 set	273	13	100	100	30	30	PPP
Sub Total		1,520	80	540	540	180	180	
Total		**3,721**	**515**	**1,117**	**1,330**	**579**	**180**	
By Fund								
Foreign Fund		999	9	274	477	239		
MRPW		470	212	120	138			
CCN		626	153	123	190	160		
PPP		1,626	141	600	525	180	180	
Total		**3,721**	**515**	**1,117**	**1,330**	**579**	**180**	

Pilot Project Experiment

Main Objectives

- To examine effects and impacts of improving geometrical configurations of junctions as well as installation of signal system.
- To feedback the above to the formulation of the Master Plan as well as in similar projects in future that will be selected in the Master Plan.

Major Works

- Installation of traffic signal system
- Improvement of geometrical alignment
- Provision of paved sidewalk
- Installation of traffic safety measures

Pre-Construction Stage

Before conducting the civil works, the following vital measures were carried out;

- Environmental clearance from NEMA
- Public announcement for project Implementation

Before the Pilot Project

Construction Stage

Before, during, and after conducting the civil works, the following monitoring measures were carried out to assess the efficiency of geometric improvement and signal installation:

- Traffic condition survey (traffic volume with movement by classification, queue length, and travel speed)
- Environmental condition survey (noise, particle matters, and air pollutants)
- Social condition survey (public opinion interview survey)

During the Pilot Project

Post Construction Stage

In the course of activating signal system, five (5) patterns of signal phasing were experimented.

After the Pilot Project

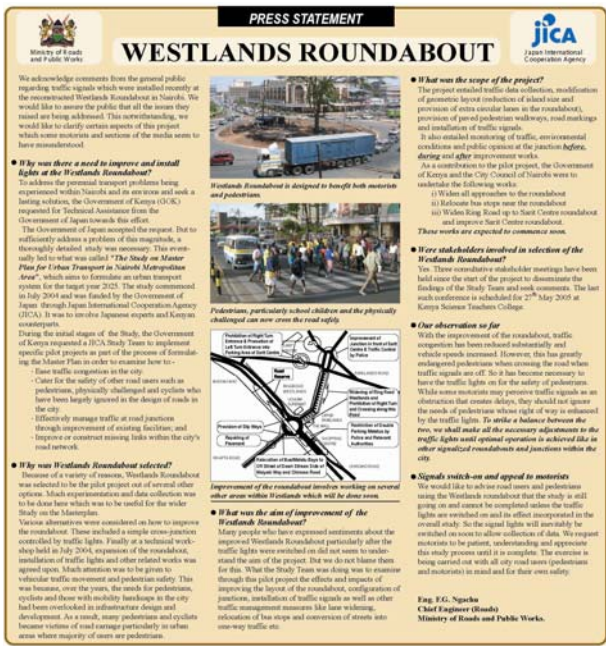
Public Opinions

- Signal Patterns 1, 2 and 3 allocated larger period for pedestrian to cross the roads safely and shorter for vehicles, which was rejected.
- Signal Pattern 5 provides very short period for pedestrians who may be subject to danger in crossing the roads, and most of time for vehicles which was accepted.
- The phenomenon reveals the fact that motorists believe to own the absolute prerogative in using roads, while pedestrians are neglected. It is strongly suggested that a policy to be established so that roads be used with the harmonized time sharing between pedestrian and motorists.

GOK's Efforts

In the course of the Pilot Project, GOK coordinated stakeholder meetings with Westlands Residents Association, and prepared public notices as well as press statement.

Press Statement



PRESS STATEMENT

WESTLANDS ROUNDABOUT

Ministry of Roads and Public Works

JICA Japan International Cooperation Agency

We acknowledge comments from the general public regarding traffic signals which were installed recently at the reconstructed Westlands Roundabout in Nairobi. We would like to assure the public that all the issues they raised are being addressed. This notwithstanding, we would like to clarify certain aspects of this project which some motorists and sections of the media seem to have misunderstood.

● *Why was there a need to improve and install lights at the Westlands Roundabout?*

To address the perennial transport problems being experienced within Nairobi and its environs and seek a lasting solution, the Government of Kenya (GOK) requested for Technical Assistance from the Government of Japan towards this effort.

The Government of Japan accepted the request. But to sufficiently address a problem of this magnitude, a thoroughly detailed study was necessary. This eventually led to what was called *"The Study on Master Plan for Urban Transport in Nairobi Metropolitan Area"*, which aims to formulate an urban transport system for the target year 2025. The study commenced in July 2004 and was funded by the Government of Japan through Japan International Cooperation Agency (JICA). It was to involve Japanese experts and Kenyan counterparts.

During the initial stages of the Study, the Government of Kenya requested a JICA Study Team to implement specific pilot projects as part of the process of formulating the Master Plan in order to examine how to:-

- Ease traffic congestion in the city
- Cater for the safety of other road users such as pedestrians, physically challenged and cyclists who have been largely ignored in the design of roads in the city
- Effectively manage traffic at road junctions through improvement of existing facilities; and
- Improve or construct missing links within the city's road network.

● *Why was Westlands Roundabout selected?*

Because of a variety of reasons, Westlands Roundabout was selected to be the pilot project out of several other options. Much experimentation and data collection was to be done here which was to be useful for the wider Study on the Masterplan.

Various alternatives were considered on how to improve the roundabout. These included a simple cross-junction controlled by traffic lights. Finally at a technical workshop held in July 2004, expansion of the roundabout, installation of traffic lights and other related works was agreed upon. Much attention was to be given to vehicular traffic movement and pedestrian safety. This was because, over the years, the needs for pedestrians, cyclists and those with mobility handicaps in the city had been overlooked in infrastructure design and development. As a result, many pedestrians and cyclists became victims of road carnage particularly in urban areas where majority of users are pedestrians.

Westlands Roundabout is designed to benefit both motorists and pedestrians.

Pedestrians, particularly school children and the physically challenged can now cross the road safely.

Improvement of the roundabout involves working on several other areas within Westlands which will be done soon.

● *What was the aim of improvement of the Westlands Roundabout?*

Many people who have expressed sentiments about the improved Westlands Roundabout particularly after the traffic lights were switched on did not seem to understand the aim of the project. But we do not blame them for this. What the Study Team was doing was to examine through this pilot project the effects and impacts of improving the layout of the roundabout, configuration of junctions, installation of traffic signals as well as other traffic management measures like lane widening, relocation of bus stops and conversion of streets into one-way traffic etc.

● *What was the scope of the project?*

The project entailed traffic data collection, modification of geometric layout (reduction of island size and provision of extra circular lanes in the roundabout), provision of paved pedestrian walkways, road markings and installation of traffic signals.

It also entailed monitoring of traffic, environmental conditions and public opinion at the junction *before, during and after* improvement works.

As a contribution to the pilot project, the Government of Kenya and the City Council of Nairobi were to undertake the following works:

i) Widen all approaches to the roundabout
ii) Relocate bus stops near the roundabout
iii) Widen Ring Road up to Sarit Centre roundabout and improve Sarit Centre roundabout.

These works are expected to commence soon.

● *Were stakeholders involved in selection of the Westlands Roundabout?*

Yes. Three consultative stakeholder meetings have been held since the start of the project to disseminate the findings of the Study Team and seek comments. The last such conference is scheduled for 27th May 2005 at Kenya Science Teachers College.

● *Our observation so far*

With the improvement of the roundabout, traffic congestion has been reduced substantially and vehicle speeds increased. However, this has greatly endangered pedestrians when crossing the road when traffic signals are off. So it has become necessary to have the traffic lights on for the safety of pedestrians. While some motorists may perceive traffic signals as an obstruction that creates delays, they should not ignore the needs of pedestrians whose right of way is enhanced by the traffic lights. *To strike a balance between the two, we shall make all the necessary adjustments to the traffic lights until optimal operation is achieved like in other signalized roundabouts and junctions within the city.*

● *Signals switch-on and appeal to motorists*

We would like to advise road users and pedestrians using the Westlands roundabout that the study is still going on and cannot be completed unless the traffic lights are switched on and its effect incorporated in the overall study. So the signal lights will inevitably be switched on soon to allow collection of data. We request motorists to be patient, understanding and appreciate this study process until it is complete. The exercise is being carried out with all city road users (pedestrians and motorists) in mind and for their own safety.

Eng. F.G. Ngacha
Chief Engineer (Roads)
Ministry of Roads and Public Works.

INTRODUCTION

INTRODUCTION

BACKGROUND

There are four major modes of transportation in Kenya for passengers and bulk freight: rail, road, maritime and air. Of these modes, the most important in terms of volume is road transport, with the most important land transport corridor being the route between Nairobi and Mombasa and then the corridor that runs from Nairobi to the west of the country towards Uganda and into the interior of Africa. An efficient transport system is a prerequisite for the rapid economic development of the country and for improving the quality of life of the people. However, the transport system of the country is far from satisfactory with low operating speeds, delays, accidents and high operating costs due to the poor condition of the road and rail infrastructure and inadequate capacity of the transport system. Over the past decade, sectorial development policy of the Government of Kenya has been to implement proper maintenance for its existing road infrastructure. Despite this, the network has deteriorated rapidly during this period. On the other hand, traffic demand has been increasing very rapidly during the past decade and there is now a shortage of road capacity to meet the rising demand.

The Government of Kenya recognizes the transport sector as a facilitator of rapid economic growth and reconstruction, poverty eradication and wealth section for the country. The importance of Non-Motorized Transport (NMT) for the mobility needs of the transport poor as well as promoting the health of the population in the urban area has been neglected.

The present supply to transport is inadequate to meet the increase in traffic demand, in particular in Nairobi Metropolitan Area. Hence, there is a need to increase the transport supply. An inadequate supply of the road capacity, road structure and traffic management measures have been causing heavy traffic congestion and traffic accidents. Accordingly, in order to alleviate this situation, construction of missing links and improvement of road structures / facilities and traffic management measures are required. The Government of Kenya decided that, in order to solve the transport problems, a comprehensive master plan covering the areas of road network improvement, public transport and traffic management should be developed with a time horizon of 2025.

In response to the request of the government of the Republic of Kenya (hereinafter referred to as “GOK”), the Government of Japan (hereinafter referred to as “GOJ”) has decided to conduct the Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area in the Republic of Kenya (herein after referred to as “the Study”) in accordance with the relevant laws and regulations in force in Japan. Accordingly, the Japan International Cooperation Agency (hereinafter referred to as “JICA”), the official agency responsible for the implementation of the technical cooperation programs of the GOJ, will undertake the Study in close cooperation with the concerned authorities of the GOK. JICA has organized and dispatched a Study Team consisting of the experts of Katahira & Engineers International and RECS International Inc. (hereinafter referred to as “the Study Team”) to Kenya to commence the study in July 2004. The Final Report is submitted to GOK in January 2006.

OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. To formulate a Master Plan for Urban Transport in the Nairobi Metropolitan Area for the target year 2025,
2. To conduct a Pre-Feasibility Study on the priority projects under the Master Plan, and
3. To carry out relevant Technology Transfer to Kenyan Counterpart Personnel in the course of the Study.

STUDY AREA

The Study covers the City of Nairobi and its surrounding areas.

Landscape of Nairobi CBD

STAKEHOLDER MEETING

A series of Stakeholder Meeting were held with particular themes. The objectives of the meetings are to discuss urban transport issues and solutions with the stakeholders, and to reflect their opinions in the transport planning processes.

- **Master Plan Phase**
  - 1st : Problem identification on urban transport in NMA and Westlands roundabout improvement, 11 Nov. 2004
  - 2nd : Master Plan scenarios and proposed projects of each transport sector, 3 Mar. 2005
  - 3rd : Recommended Master Plan and implementation priorities, 3 Mar. 2005

- **Pre-Feasibility Phase**.
  - 4th : Outline of selected studies; 27 May 2005
  - 5th : Anticipated problems in project implementation; 26 July 2005
  - 6th : Recommended mitigation measures in project implementation; 23 Aug. 2005

TECHNOLOGY TRANSFER

The technology applied to the Study was made available to be transferred to the Kenyan side through the possible methods in all stages of the plan formulation process.

Steering Committee

The Steering Committee was established by GOK to discuss the methodology and outcome of the Study, presented in the Progress Report, the Interim Report, Draft Final Report.

Technical Workshop and Seminar

Technical workshops were held to discuss and exchange ideas on the study methodology and outputs, and confirm the details of the plan, on two times of the commencement of the Study and six (6) times prior to the stakeholder meetings. A seminar was held before or after the presentation of the Draft Final Report.

On-the-Job Training

Experts from the Ministry of Roads and Public Works (MRPW), Ministry of Local Government (MOLG) and City Council of Nairobi (CCN) were assigned as the counterparts to work with the Study Team on part time basis. They were given hand-on training throughout the Study. Specifications and formats used in the various surveys of the Study can serve as a reference in similar projects in the future.

Counterpart Training in Japan

Counterparts training in Japan were held twice; in September 2005 and September-November 2005.

Major Subjects of Technology Transfer

The major subjects of technology transfer included, among others, the following;

- Planning methodology of urban transport
- Road condition and inventory survey
- Land use surveys and data analysis
- Planning, implementation, monitoring and evaluation of pilot project
- CAD/GIS computer skills
- Planning concept and procedures for road, public transport, and traffic management.

Contribution by the Kenyan Side

Major contribution by the Kenyan side was made in the following areas:

- Establishment of development policy
- Establishment of future land use schemes for major transport projects
- Pilot project experiment

Accomplishment

Considerable accomplishment was made in the technology transfer. The capacity of the counterparts has been substantially improved in the following specific areas:

- Traffic surveys and data analysis
- Road condition survey and compilation of road inventory
- CAD/GIS operation
- Planning concept and procedure on transport study

The effort and dedication of the counterparts should be noted. The Study Team owes much to their cooperation and assistance.

Technical Workshop

PART I

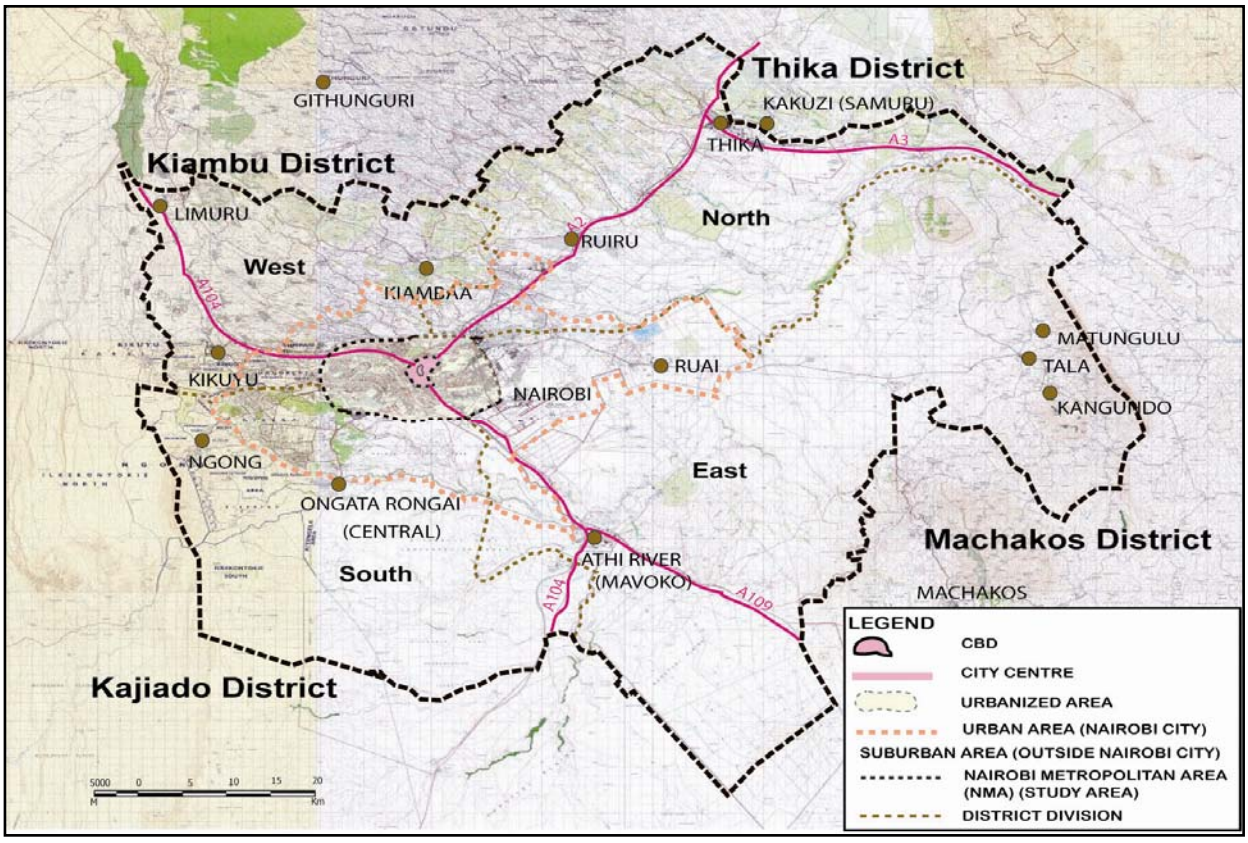
PRESENT AND FUTURE ISSUES

1. PHYSICAL PROFILE

(1) Characteristics of NMA

- The Nairobi Metropolitan Area (NMA) has a mean altitude of approximately 1,700 meters (5,600 ft) above sea level. It is divided into two physiographic units or land forms. The western portion is on high ground (approximately 1700-1800 meters ASL) with rugged topography, while the eastern side is generally low (approximately 1600 meters ASL) and flat.
- The Study Area is divided into five (5) areas in accordance with the extent of land development and magnitude of socio-economic activities.
  - Central Business District (CBD)
  - City Center
  - Urbanized Area
  - Urban Area (Nairobi City)
  - Suburban Area (Outside Nairobi City)
- CBD is defined as the area surrounded by the Uhuru highway, the Moi avenue, the University way and the railway, where business and commercial functions concentrate.
- City Center area contains old town where history of the area originates from the beginning of Nairobi City in 19th Century. The area surrounded by Lusala Road, Mbagathi Road, Ngara Road is basically defined as City Center of Nairobi.
- Urbanized Area defined as outer of City Center with 5 to 7 km radius from CBD. The area is surrounded by Karura forest to the north, Outer Ring Road to the east, and Kingara road to the west.
- Urban area is defined as the administration area of Nairobi City, where land development has been observed with traffic congestion.
- Suburban area is defined as the outer area of the urbanized area, including district towns and municipalities, where land has not been well developed except centers of towns. The area extends to Thika, Machakos, Kajiado, and Kiambu districts, as shown in the figure below.

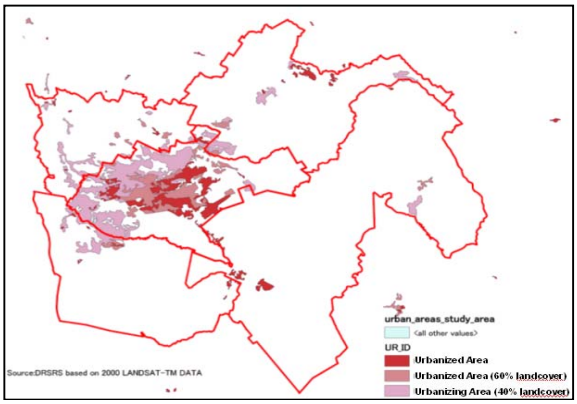
Study Area: Nairobi Metropolitan Area (NMA)



(2) Urbanization Trend

- The urbanization in the NMA has proceeded toward the northeast along the Thika road, the southeast along the Mombasa road, and the east along the Kangundo road, resulting in a radial urbanization pattern.
- A large population increase is observed in the eastern area as against the Nairobi Metropolitan Growth Strategy, while the Karen-Langata area has not absorbed much of population increase. The population density in the Old Town has increased which is also against the Growth Strategy. The complex and multiple corridor development as proposed in the Growth Strategy has not been realized.

Urbanization Trend

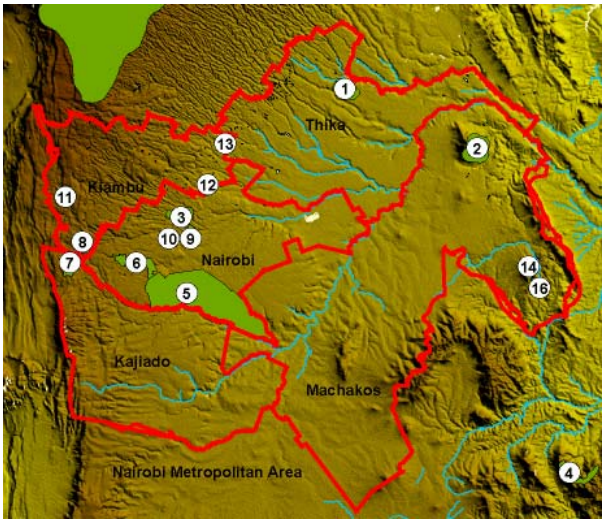


- In the National Metropolitan Growth Strategy, formation of local centers of public services and local industries are proposed at Kiambu, Kikuyu, Limuru, Machakos, Athi River, and Thika. Out of these municipalities and townships, only the Athi River town and the Thika municipality have grown as local centers with accumulation of local industries and considerable work places.
- Factories and firms sited along the Mombasa road in the past 30 years and EPZs are scattered within the NMA. Evidence of industrial area formation for the informal sector can be seen along some intra-regional trunk roads.

(3) Geological Feature and Conservation Area

- The Nairobi Metropolitan Area (NMA) falls largely in the drainage basin of the Athi river and its tributaries. The Nairobi river, a major tributary, flows generally from the southwest to the northeast through Nairobi City, and is joined by the Kamiti, Thiririka and Nalaruru rivers in the eastern part of the NMA before it drains in the Athi river.
- There are various conservation areas in the NMA including two national parks, forest areas and city parks of Nairobi.
- The Nairobi National Park in the south of Nairobi City is the largest conservation area within the NMA with a land area of 117 km^2. The Oldonyo Sabuk National Park is in the east of the NMA, and has the land area of 18.5km^2.

Geographical Feature



Note: Number represents forest conservation area

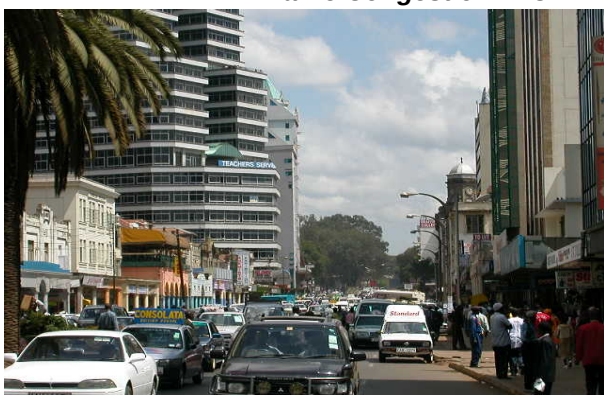
- Thika District has a topography ranging from 1,400 m to 1,600 m above the sea level. The eastern parts of the district are lowlands, which cover Ruiru Division and Thika Municipality.
- Kiambu District is characterized by hills, plateaus and high plains which makes it fairly easy for the development of road network.
- Machakos District has a variety of topographical feature, and is largely a plateau.
- Kajiado District is characterized by the Athi Plains and the Ngong Hills and is the source of Athi River.

2. PRESENT TRANSPORT ISSUES

(1) Urban Structure

- Disorderly and low density outward expansion of urbanization are due to the absence of land use plan and control
- Urban activities only concentrate inside CBD or in the city center where traffic congestion is serious.
- Economic development is constrained due to inefficient and ineffective road network.

Traffic Congestion in CBD



(2) Road Network Conditions

- International Corridor
  - International highways are substandard which hampered efficient mobility.
- Road Network in CBD
  - No new road and widening spaces within road reserve is found.
  - Streets around City Hall require street beautification.
- Road Network in City Center
  - There are only two (2) roads connecting CBD in the east and administration zone on hilly area in City center
- Road network in Urbanized Area
  - Hierarchy of the road network has not been well developed
  - Poor mobility and accessibility of collectors are due to many missing links
  - Local streets are not functionally connected to collectors
- Road Network in Sub-urban Area
  - The main road network connecting Nairobi and sub-urban center has been reasonably developed
  - Pavement conditions in some areas deteriorated in some sections
  - Traffic condition on arterials in 2004 is below acceptable level of service
  - Road maintenance is poor due to inadequate staff and equipment for maintenance and lack of funds

(3) Public Transport

- Insufficient network of Buses and Matatu
  - No regulation is implemented to clearly distinguish the roles of Bus and Matatu
  - No existence of coordination between Bus and Matatu for sharing and integration
- Non-incentives to private sectors
  - Public transport services are based on business viewpoint sacrificing the value of public service, safety and security.
- Railway service
  - The use of existing railway in commuting is insufficient. The ridership is low while the infrastructure is poorly maintained.

Railway Station

(4) Traffic Management

- Lack of traffic management system
- Increase of traffic accident and insecurity
- On-street parking in the city center
- Lack of parking spaces in the urbanized area

(5) Environment

- Increase of slum population
- Restoration of forest area
- Poor roadside amenity
- No spaces for non-motorized transport
- A few provision of bus bay for safe riding
- Aggravation of air and noise pollution

(6) Legislation and Organization

- Unclear management responsibility
- Uncoordinated transport infrastructure
- Inappropriate planning mechanism for development and maintenance

(7) Finance for Transport Infrastructure

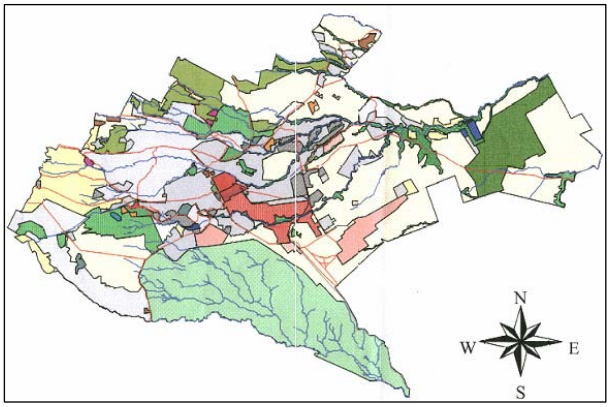
- Inadequate, fragmented and arbitrary allocation of funds
- No innovative ways of generating funds

3. SOCIO-ECONOMIC FRAMEWORK

(1) Land Use in Nairobi City

- Nairobi City is the centre of population and businesses and also functioning as a centre of transport, communication, industry and politics in Kenya.
- Western and northern hilly areas are formed as low-density residential areas for high-income class, while northern areas adjacent to central area of Nairobi are formed as those for middle-income class. Residential areas for low-income are generally formed to the south and east of industrial areas in the central area of Nairobi.

Land Use in Nairobi



- Export Processing Zones (EPZs), the strategic industrial foothold based on the national economic development policy have been established along trunk road and in the east of Nairobi City.
- Small and Medium Enterprises (SMEs) have been located sporadically in the surrounding District in the NMA. In particular, food processing industries based on agricultural produce are located in the areas with high agricultural potential in Thika and Kiambu.
- Commercial cores have been developed at nodal points of road transport outside of CBD of Nairobi City.
- Large scale tea and coffee plantations for foreign and domestic markets and small scale farming are dominated in western and northern parts of Nairobi Metropolitan Area.

(2) Future Urban Structure Alternative

- Since there are no official urban structure plan except 'Nairobi Metropolitan Growth Strategy'" provided in 1973, the Study Team prepared the urban structure Plan and land use plan as prelude for this transport study.
- Three (3) typical future land use patterns of the NMA were examined, and transport corridor patterns supporting the land use patterns were studied. Consequently, the following urban structure alternatives were considered as a result of the combination of future urban land use patterns and supportive transport corridors.

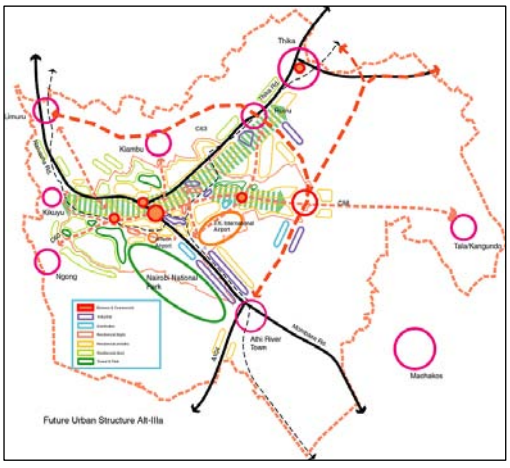
Urban Structure Alternatives

Land Use / Corridor	I. Trend Type	II. Belt Type	III. Circular Type
a. Belt-Ring Type	-	Alternative-IIa	Alternative-IIIa
b. Belt Type	-	Alternative-IIb	-
c. Radial Type	Alternative-Ic	-	-

- Out of several alternatives, Alternative-IIIa (Circular Type Development with Belt-Ring Type Transport Corridors) is recommended based on the following merits:

  Fostering Regional Growth Center
  - Enhancing Land Use Potential
  - Guiding Current Urbanization Properly
  - Mitigating Traffic Congestion on Radial Arteries
  - Formulating New International and Regional Corridor
  - Minimizing Conflict between Development and Wild Animals.

Future Urban Structure



(3) GDP and GDP per Capita

- The GDP of Kenya is expected to grow from KSh 1,036 billion in 2004 to KSh 2,643.7 billon in 2025 with an average annual growth rate of 4.6 %. As a result, GDP per capita is expected to increase from KSh 31,600 in 2004 to KSh 57,100 in 2025 with an annual growth rate of 3.0%.

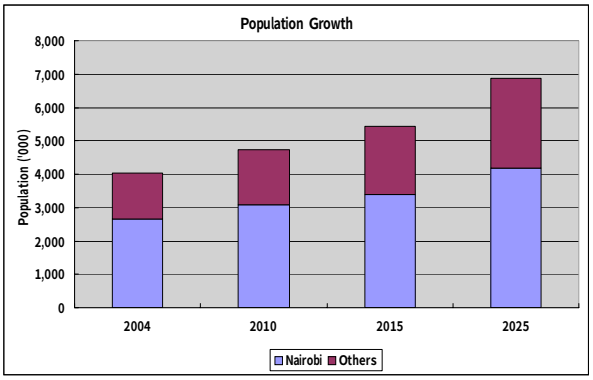
GDP Growth Rate

	2004-2010	2010-2015	2015-2025
GDP	4.3	4.8	4.6
GDP per Capita	2.5	3.0	3.0

(4) Population

- Population of the Study Area is estimated to grow by about 1.72 times from 4,041,900 in 2004 to 6,960,000 in 2025, or 2.1% per year of which Nairobi City accommodates about 60% of population or 4,176,000 inhabitants.

Population Growth



(5) Employment

- Working population is estimated by applying participation rate to the workable population. Employment in the future is estimated based on the forecast result of population in NMA and participation rate for work. Employment in the Study Area is estimated as more than 4 million in 2025.

Working Population

	2004	2010	2015	2025
Study Area	2,167	2,888	3,334	4,072
Nairobi	1,928	2,541	2,834	3,257
Others	239	347	500	815

(6) Vehicle Ownership

- The number of vehicles is estimated on the basis of relationship between vehicle ownership rate and household income. Using future household income and vehicle ownership rate model, the future number of vehicle is forecasted and the results are shown below.

Vehicle Ownership *(Unit: thousand)*

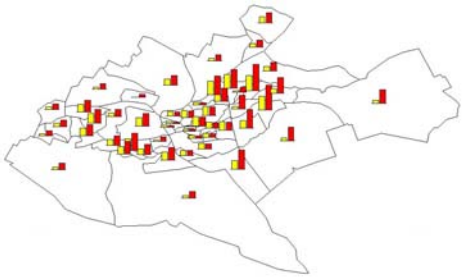
	2004	2010	2015	2025
No. of households	889.3	1,054.2	1,176.2	1,455.5
Car Ownership Rate (%)	23.3	31.1	41.3	49.2
No. of Car	207.3	327.4	486.2	716.1

(7) Zonal Framework in 2004 and 2010

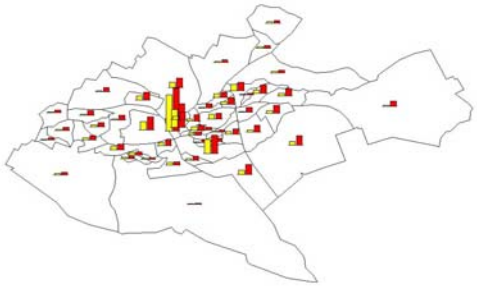
- The socio-economic framework is formulated on the basis of zonal land use with a total of 153 zones.

Zonal Framework in 2004 and 2025

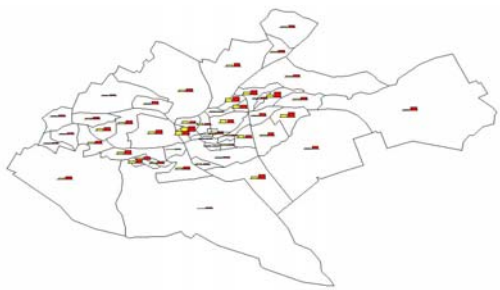
Population by Zone



Workers at Office (Base)



Students at Enrolment Place (Base)

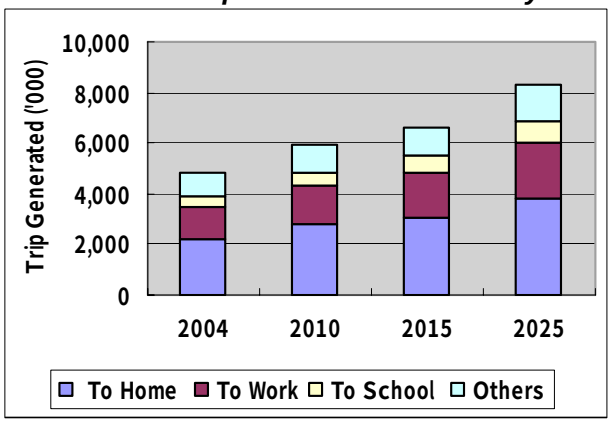


4. FUTURE TRANSPORT DEMAND

1) Future Total Trips

- Based on the cross-classification trip rate and the future framework, total trips generated in the Study Area are estimated as 4,815,000 in 2004 and 8,276,000 in 2025.

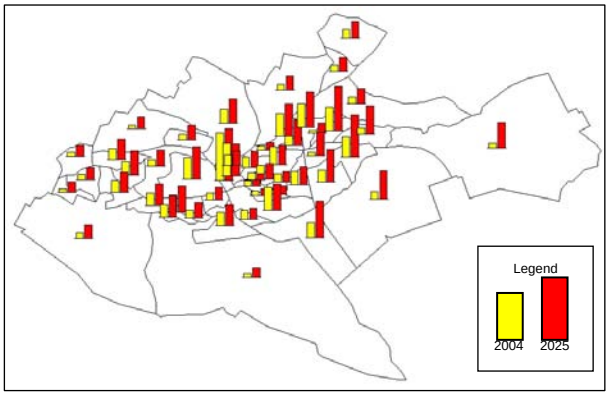
Total Trip Generated in the Study Area



(2) Trip Generation and Attraction

- Based on the trip generation and attraction model developed in this Study and zonal socio-economic framework, trip generation and attraction is estimated to grow 1.7 from 2004 to 2025.

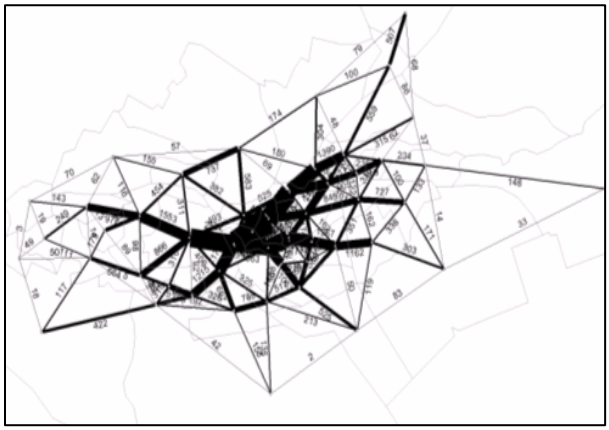
Trip Generation and Attraction in 2004 & 2025

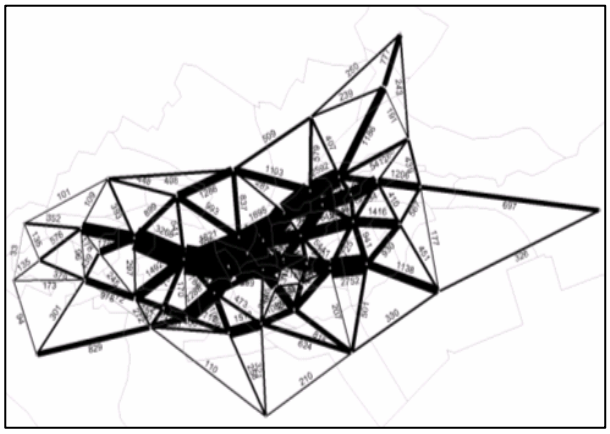


(3) Trip Distribution

- The gravity model for inter-zonal trips and trip rate model for the intra-zonal trips are applied for trip distribution forecast. Based on the trip distribution in 2004 and 2025, the charts by spider network assignment method, are established to show the present and future zonal trip distribution.

Trip Distribution in 2004

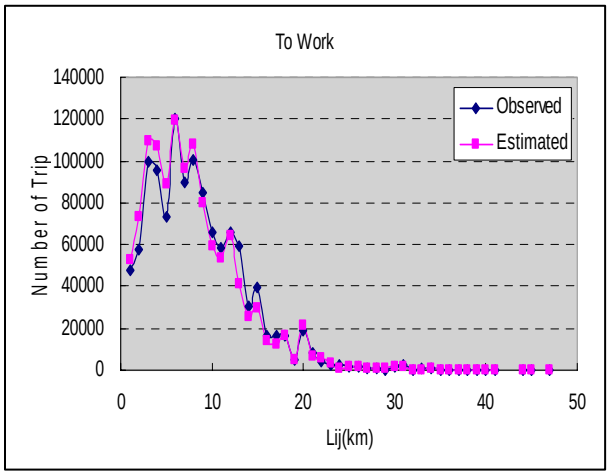




Trip Distribution in 2025

- The verification of trip distribution model is made by comparing observed and estimated trip length. The trip distribution model developed is verified to be accurately computed in this Study.

Verification of Trip Distribution

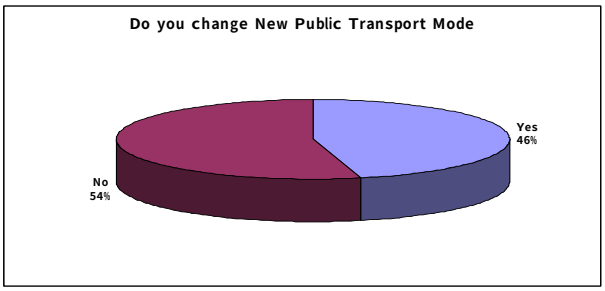


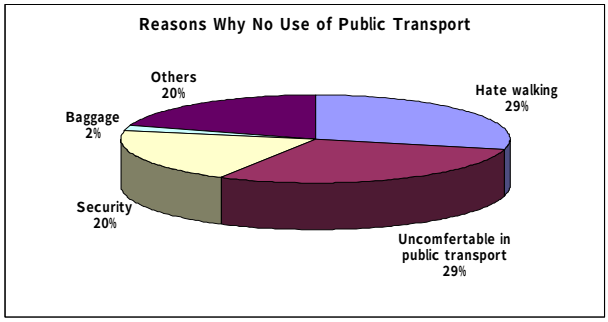
Note: LIj is length or distance of trip

(4) Modal Split

- In order to estimate the future modal split, a person-trip survey together with the Stated Preference (SP) Survey was conducted in the Study. According to the SP Survey, the potential modal shift of car users gives approval rate of 46% mostly to avoid walking or existing public transport system.

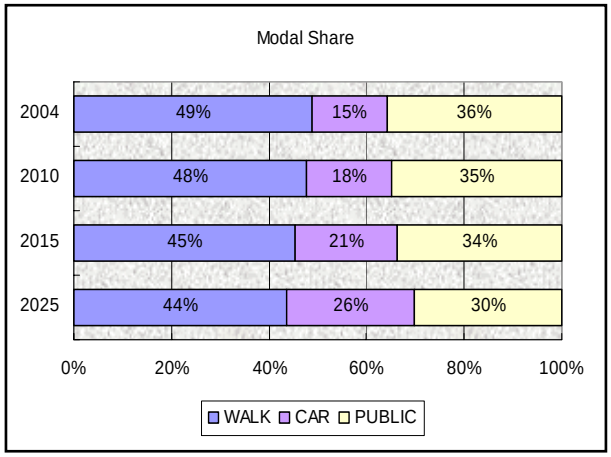
Potential Mode Shift of Car Users





- Modal split models are used to analyze and predict the choice that individuals make in choosing the transportation modes for particular type of trips. The most commonly applied method to study modal split is the logit model.

Future Modal Share under Do-Nothing Case

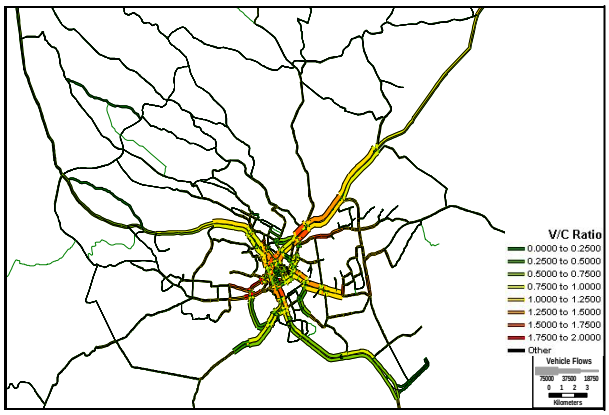


- Comparing the future estimation with the existing case, the number of private vehicles increases almost three (3) times, while the share of private mode trips will be doubled, which reflect the high increase of car ownership rate.
- On the other hand, the number of public transport trips will increase slightly, but the share of public transport demand will decrease.

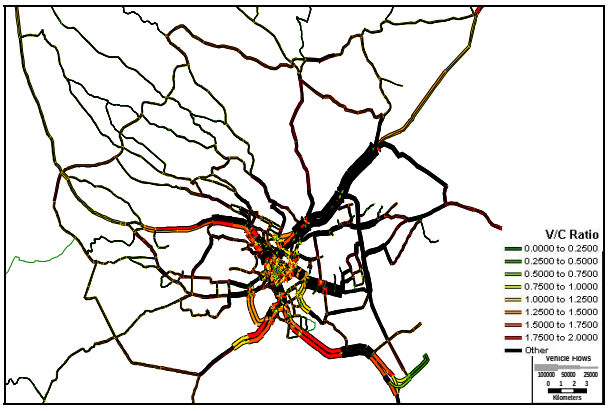
(5) Future Traffic Assignment

- The traffic assignment was made by applying a user equilibrium assignment technique prepared by TRANSCAD. This technique assumed that every traveller has perfect information regarding the attributes of network alternatives, all travellers choose routes that minimize their time or travel costs, and all travellers have the same valuations of network attitudes.

Traffic Assignment (2004)



Traffic Assignment in Do Nothing Case (2025)



(6) Assessment of Present Network Condition

- The traffic indicators by year were evaluated from the view point of change of vehicle trips, PCU-hours, PCU-km and average speed.
- Vehicle trips are increasing each year; 779 thousands PCU in 2004 becomes 1,933 thousands PCU in 2025, which is approximately 2.5 times higher than that of 2004. Following the increase of vehicle trips, indicators of PCU-hour and PCU-km also increase, in particular PCU-hour drastically increased from 286 thousands in 2004 to 2,484 thousands in 2025. This increase is 8.4 times higher than that of 2004.
- As a result of change of vehicle trip, average speed in the study is reduced from 34.7 km/h to 11.2 km/h, which means the road's level of service has deteriorated that could have severe economic and environmental impact.

Vehicular Traffic Assignment in Do-Nothing Case

	Year 2004	Year 2010	Year 2015	Year 2025
Total Vehicle Trips (in PCU)	779,774	1,055,821	1,331,490	1,933,581
PCU-Hour ('000)	286	554	903	2,484
PCU-Km ('000)	9,935	14,260	17,984	27,934
Average Speed (km/hr)	34.7	25.7	19.9	11.2

Assessment of Present Transport Network Condition-Urbanized Area

Year					2004			2010 Do Nothing			2015 Do Nothing			2025 Do Nothing		
	Area	Name of Road	No. of Lane	Capacity (PCU)	Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane	Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane	Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane	Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane
Radial Road	North	R-6 Thika Road	4	60,000	60,577	1.01	6	93,059	1.55	8	107,493	1.79	10	142,824	2.38	12
		S-5 Kiambu Road	2	25,000	16,390	0.66	2	28,689	1.15	4	36,631	1.47	4	48,436	1.94	4
	East	R-7 Koma Rock	2	25,000	10,923	0.44	2	21,736	0.87	4	26,983	1.08	4	42,693	1.71	4
		S-7 Kangundo Road	2	20,000	7,470	0.37	2	18,808	0.94	2	23,424	1.17	4	36,167	1.81	4
	South East	R-1 Mombasa Road	4	50,000	27,961	0.56	4	40,742	0.81	4	50,893	1.02	6	78,897	1.58	8
	South West	R-2 Langata Road	2	25,000	19,415	0.78	2	30,088	1.20	4	37,495	1.50	4	53,754	2.15	6
	West	R-3 Ngong Road	2	25,000	11,199	0.45	2	11,806	0.47	2	15,922	0.64	2	24,078	0.96	2
		S-3 Naivasha Road	2	25,000	8,474	0.34	2	16,581	0.66	2	19,717	0.79	2	32,128	1.29	4
	North West	R-4 Waiyaki Way	4	50,000	39,616	0.79	4	51,133	1.02	6	62,303	1.25	6	86,564	1.73	8
		R-5 Limuru Road	2	25,000	6,432	0.26	2	9,141	0.37	2	12,911	0.52	2	26,155	1.05	4
		Red Hill Road	2	25,000	5,584	0.22	2	6,597	0.26	2	12,052	0.48	2	27,037	1.08	4
		S-4 Lower Kabete Road	2	25,000	10,707	0.43	2	19,325	0.77	2	24,211	0.97	2	36,834	1.47	4
	Radial Road Total		**30**	**380,000**	**224,748**	**0.59**	**32**	**347,705**	**0.92**	**42**	**430,035**	**1.13**	**48**	**635,567**	**1.67**	**64**
Ring Road	East	C-3 First Avenue	2	20,000	12,346	0.62	2	21,685	1.08	4	27,429	1.37	4	37,967	1.90	4
		C-4 Outer Ring Road	2	25,000	26,214	1.05	4	45,086	1.80	4	52,369	2.09	6	71,676	2.87	6
	West	C-2 Mbagathi Road	4	50,000	22,913	0.46	4	38,694	0.77	4	48,514	0.97	4	73,051	1.46	6
		C-4 James Gichuru Road	2	20,000	16,677	0.83	2	22,935	1.15	4	28,968	1.45	4	40,412	2.02	4
	Ring Road Total		**10**	**115,000**	**78,150**	**0.68**	**12**	**128,400**	**1.12**	**16**	**157,280**	**1.37**	**18**	**223,106**	**1.94**	**20**
Urbanized Area Total			**40**	**495,000**	**302,898**	**0.61**	**44**	**476,105**	**0.96**	**58**	**587,315**	**1.19**	**66**	**858,673**	**1.73**	**84**

Assessment of Present Transport Network Condition-Central Area

	Area	Name of Road	No. of Lane	Capacity (PCU)	2004			2010 Do Nothing			2015 Do Nothing			2025 Do Nothing		
					Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane	Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane	Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane	Traffic Vol. (PCU)	V/C Ratio	Required No. of Lane
Radial Road	North	R-6 Muranga Road	4	50,000	83,849	1.68	8	116,640	2.33	10	137,663	2.75	12	178,826	3.58	14
	East	R-7 Jogoo Road	4	50,000	63,601	1.27	6	84,653	1.69	8	100,198	2.00	10	133,133	2.66	12
	South East	R-1 Mombasa Road	4	50,000	39,313	0.79	4	51,538	1.03	6	61,253	1.23	6	82,249	1.64	8
	South West	R-2 Langata Road	4	60,000	44,123	0.74	4	61,650	1.03	6	74,717	1.25	6	102,927	1.72	10
	West	R-3 Ngong Road	2	25,000	30,148	1.21	4	50,706	2.03	6	55,450	2.22	6	73,834	2.95	6
	North West	R-4 Chiromo Road	6	75,000	72,693	0.97	6	89,132	1.19	8	105,829	1.41	10	143,081	1.91	12
	Central Area Total		**34**	**420,000**	**407,579**	**0.97**	**44**	**563,850**	**1.34**	**58**	**666,104**	**1.59**	**66**	**898,592**	**2.14**	**82**

PART II

TRANSPORT MASTER PLAN

5. TRANSPORT DEVELOPMENT POLICY PLAN AND TARGET

(1) Transport Issues

As presented in PART I, there are various transport problems in the Study Area that are identified as follows;

Urban Structure

- No land use plan/lack of land use control
- Concentration of urban activities only in the city centre

Road Network

- Substandard of international corridor
- No hierarchy of road network system
- Many missing road links
- Traffic congestion due to inadequate transport facilities and network function

Public Transport

- Inefficient network and operation of bus/matatu
- Poor infrastructures and operation of railway

Traffic Management

- Traffic accidents and insecurity
- On-street parking in the city center

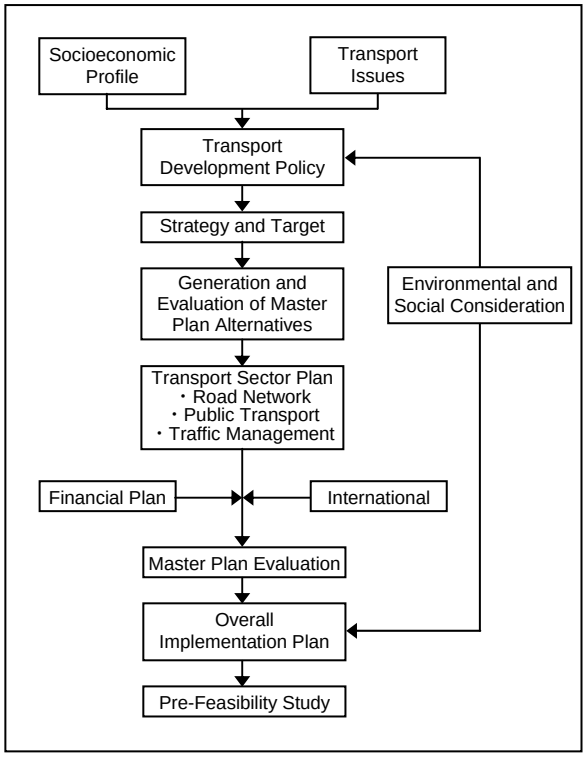
Environment

- Lack of space for non-motorized transport
- Poor roadside amenity

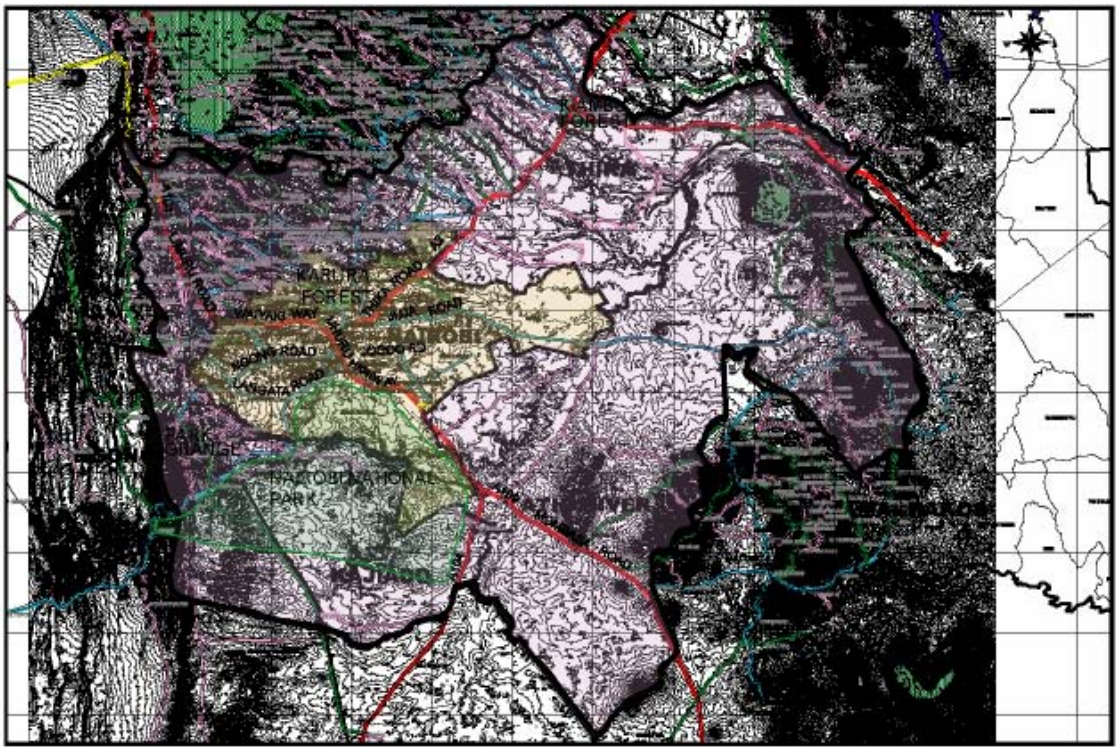
(2) Planning Approach

The comprehensive road systematic planning approach is adapted to develop the future transport system adaptable for the Nairobi Metropolitan Area.

Planning Procedure



Topographical Conditions and Arterial Road Network



(3) National Transport Policy of Kenya

- The Government of Kenya recognizes the transport sector as a facilitator of rapid economic growth and reconstruction, poverty eradication and wealth creation for the country. To enable the transport sector effectively play its role, the MOTC formulated "Recommendation on Integrated National Transport Policy" in February 2004, as follows:

- The Policy is set forth to establish a world class transport system that is integrated and responsive to the needs of people and industry.

World Class Transport System, Uhuru Highway

- The policy emphasizes the importance of Non-Motorized Transport (NMT) in addressing the mobility needs of the poor as well as promoting the health of the population. In this regard, integration of NMT into design, development and operation of all modes of transport is recommended.

Non-Motorized Transport

- **Policy Principles**
  The highlights of the policy principles are;
  - Clarification of the roles
    - central and local government
    - non-government bodies
    - private sector
  - User's pay and polluter pay to facilitate economic efficiency
  - Stakeholder consultation in setting of tariffs and other prices
  - Financing of economic infrastructure through user charge or cost recovery.
  - Application of junctions in transport planning, operations and management.
  - Financing of social and strategic infrastructures through subsidization.
- **Mission Statement**
  The mission statement is to develop, operate and maintain an integrated transport system in order to achieve national and regional development aspirations in a socially, economically and environmentally sustainable manner.
  - Efficient, cost effective, reliable, safe, secure and integrated transport system.
  - Coordinated transport infrastructure for efficient movement of passengers, freight and mail.
  - Appropriate transport in land use planning and management system
  - Appropriate institutional system for management and regulation
  - Practicable funding mechanism
- **Transport Planning Issues**
  The Policy covers issues related to transport infrastructure planning, development and management, legal, institutional and regulatory frameworks.
  - New strategic direction for the transport sector in Kenya.
  - Legal, institutional, and regulatory framework for transport.
  - Optimal planning framework and maintenance of transport infrastructure.
  - Optimal planning and provision of transport materials.
  - Enhancing transport safety and security.
  - Competition and complementarily for effective transport delivery.
  - Land use planning and mitigation of environmental effects of transport.

(4) Transport Development Strategy

In line with the National Transport Policy, the urban transport development policies and strategies for the Study took into consideration the present transport issues and the future socioeconomic development, and covered all sub-transport sectors.

- **Development Policy**
  The development policies for each sector involve the followings:

  - International Level of Improvement
    Nairobi is the capital city of Kenya, and the center in the East African Region. It is, therefore, recommended that the level of transport facilities and services be superior and meet the international standard; especially for the international facilities.

  - Development of Hierarchical Road Network System
    The hierarchy of the road network system composed of strategic arterials, principal arterials, secondary arterials, collectors and local streets should be efficiently developed.

  - Promotion of Bus Transport
    A shift to high occupancy vehicles by public transport operation is one of keys in solving urban transport issues as well as offering services to transportation of the poor.

  - Upgrading of Railway Transport
    The services of the existing railway operation do not cater the needs of passengers due to aging infrastructure and facilities. Upgrading the existing system is therefore imperative.

- **Special Consideration**
  The special considerations are given to the followings;
  - Widespread use of NMT for low income individuals by construction of footpath, bus stops, etc.
  - Traffic control management by enhancing transport safety and security.
  - Study on traffic demand management.
  - Environmental and social consideration as an absolute pre-requisite.

(5) Plan Targets

- **Level of Service (LOS)**
  The level-of-service in 2025 should not be inferior to the present average level while the average travel speed should not be lower than the present average speed.

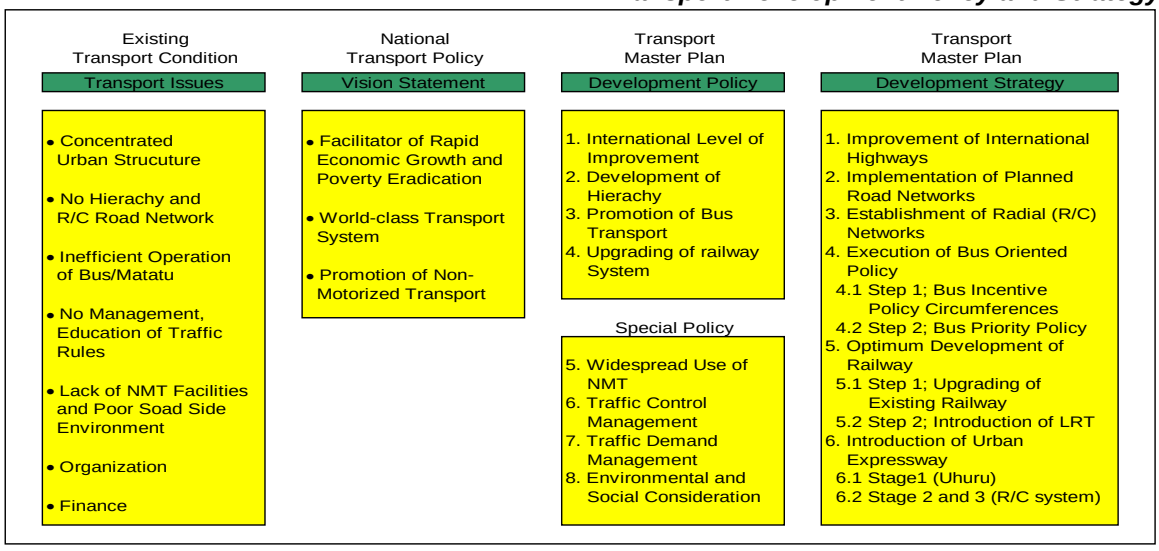
- **Accessibility Coverage**
  The coverage rate is defined by road density within the area surrounded by arterials or by the travel time of zonal population to the city center. The target rate in 2025 should be denser than the present value.

- **Traffic Parameters**
  The parameters of vehicle-kilometer, vehicle-hour and volume capacity ratio will be used as indicators for Master Plan efficiency compared with the present value.

Plan Target

Design Category	Road Class	Class	LOS	Average Travel Speed (km/h)
High Speed	International Highway	I	B	60
Urban	Principal Arterials (Ring and Circumferential Road)	II	C	40
Urban	Minor Arterials (Arterial other than above)	III	C	30
Urban	Collectors and others	IV	D	20

Transport Development Policy and Strategy



6. TRANSPORT MASTER PLAN ALTERNATIVES

(1) Basic Components of Master Plan

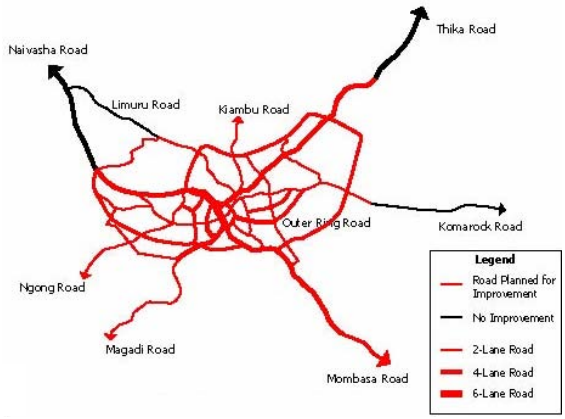
The followings are the major components of the Master Plan.

Planned Road Network

The Government previously identified the planned projects and comprised of the following projects:

- 3 - Bypass
- 2 - Link Roads
- 4 - Radial Roads
- 19 - Missing Links
- 19 - Intersection Improvement
- Non-Motorized Transport
- Traffic Management

Radial and Circumferential Road Network

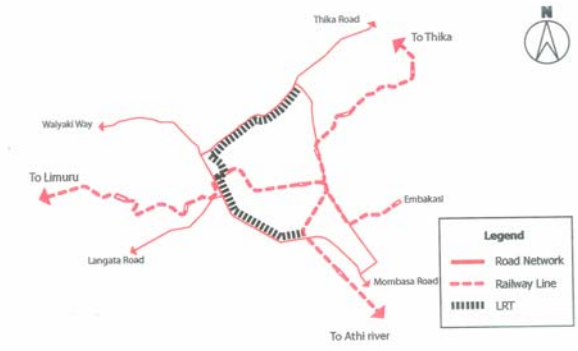


Bus Priority Measure

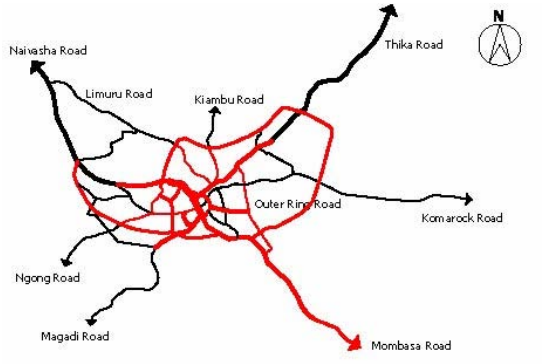
Public passenger transport system, i.e. bus and matatu, is optimal when regulation and infrastructure are provided to facilitate its operation. In accordance with this policy, the bus priority policy and measures are established including the following:

- Restructuring of bus and matatu routes along major public transport corridors.
- Provision of bus stops and terminals
- Incentives in the form of taxes, credit, etc.
- Designation of exclusive bus lanes along seven (7) major corridors.

Rail System



Planned Road Network

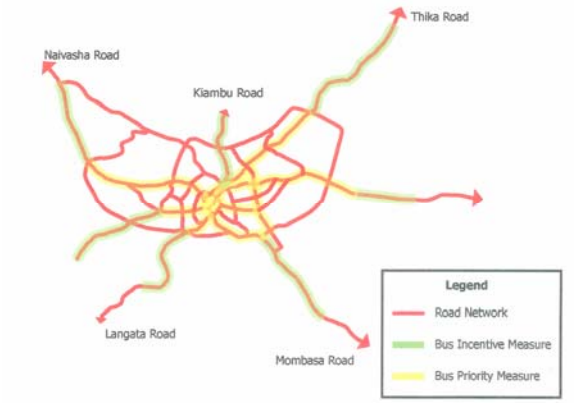


Radial and Circumferential Network (R/C)

The R/C road network is proposed to provide efficient and hierarchical road network which will ensure the accessibility and mobility of road passenger transport.

- R/C Network
  - 3 - Circumferential Roads
  - 8 - Radial Roads
- R/C Road Network (1) including improvement of existing roads and planned projects with alignment modification.
- R/C Road Network (2) consisting of R/C (1) and extension of eastern and western bypass and Nairobi River Road.

Bus Priority Measure



Rail System

The constraints faced by the existing rail system are unreliability and ageing structures, telecommunication, signalization, etc. The extent of urban commuter service is limited by the ageing infrastructure and inefficient network despite the great demand for the services, which should be improved by the following measures at the earliest possible time.

- Improvement of Existing Railway
  4-lines (Thika, Athi River, Embakasi and Limuru)
- Introduction of Light Rail System (LRT
  1 – line (Thika Road – Moi Avenue)

(2)Master Plan Alternatives

In developing the Master Plan alternatives, the following components are taken into consideration including the major components.

- Road Improvement
  - Planning Projects
  - R/C Network (1)
  - R/C Network (2)
  - Expressway system, stage 1, 2, and 3
- Public Transport
  - Bus Incentive Policy
  - Bus Priority Policy
  - Improvement of existing rail
  - Light Rail Transport(LRT) for commuter

Do Nothing; Present Road Network and Present Traffic Pattern

This case is assumed to be used as the base for evaluating the alternatives. In this case, the road network is assumed to be the same as the present one.

Alternative 1; Basic Policy

This Alternative assumes the implementation of basic policy comprising of 1) the road network with completion of planned projects and 2) bus incentive policy.

Alternative 2; Expanded Basic Policy (1)

The expanded basic policy (1) is the expansion / enhancement of basic policy to provide higher mobility and accessibility of road network (R/C road network (1)) and to enact the policy of encouraging more utilization of bus (Bus Priority Policy).

Alternative 3; Expanded Basic Policy (2)

The expanded basic policy (1) is further expanded to include the upgrading of existing rail and improvement of Uhuru Highway in addition to R/C road network (2) and bus priority policy.

Alternative 4; Rail Oriented System

This Alternative is the alternation of Alternative 3, which assumes the rail oriented urban transport system introducing a new railway along the high demand corridors.

Alternative 5; Expressway Oriented system

This Alternative is also the extension of Alternative 3, which aims at establishing the expressway oriented urban transport system of expressing stage 1, 2 and 3.

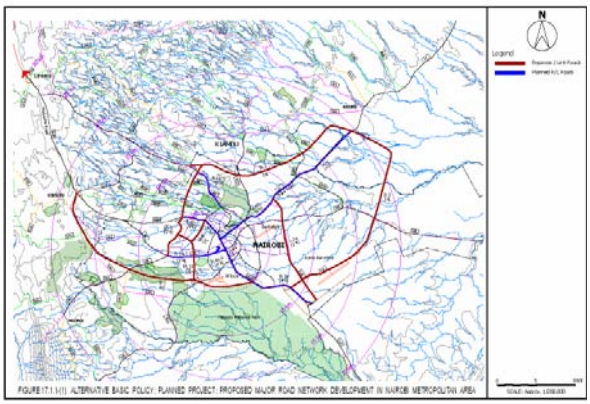
Alternative 6; Ideal Urban Transport System

This Alternative assumes the introduction of the ideal urban transport infrastructures and services such as 1) R/C road network, 2) Bus priority policy, 3) upgrading of existing rail, 4) new railway (LRT) and expressway stage 1, 2 and 3.

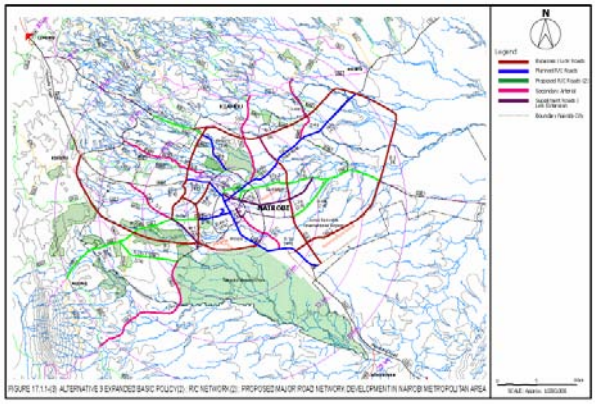
Master Plan Alternative

Alternatives	Main Policies	Road Development			Public Transport				LRT	Expresssway
		Present	Planned Projects	R/C Network	Present	Bus Incentive	Bus Priority	Existing Rail		
Do Noting	- Present Road Network - Present Traffic Pattern	○			○					
Alternative 1 Basic Policy	- Planned Projects - Bus Incentive Policy		○			○				
Alternative 2 Expanded Basic Policy (1)	- R/C Road Network (2)			○			○			
Alternative 3 Expanded Basic Policy (2)	- R/C Road-Network (2) - Bus Priority Policy - Existing Rail - Improvement of Uhuru Highway			○			○	○		
Alternative 4 Rail Oriented System	- R/C Road Network (2) - Bus Priority Policy - Existing Rail - LRT			○			○	○	○	
Alternative 5 Expressway Oriented System	- R/C Road Network (2) - Bus Priority Policy - Existing Rail - Expressway			○			○	○		○
Alternative 6 Ideal Urban Transport	- R/C Road Network (2) - Bus Priority Policy - Existing Rail - LRT - Expressway			○			○	○	○	○

Alternative 1: Basic Policy



Alternative 3: Expanded basic Policy (2)



(3) Comparative Evaluation of Alternatives

1. Evaluation Method

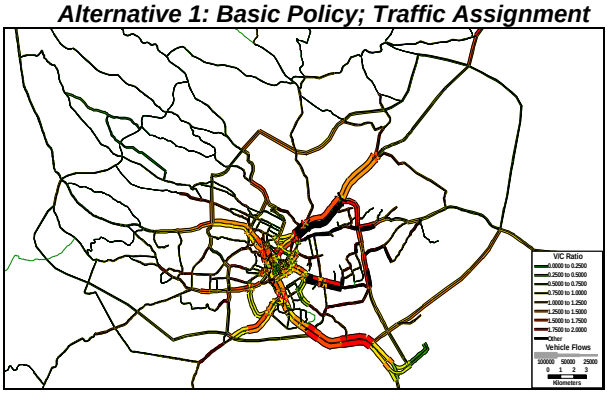
The Master Plan alternatives were comparatively evaluated based on the five (5) factors.

- Economic viability
  - Benefit Cost Points (B/C Ratio)
  - EIRR
- Traffic Condition
  - Average Travel Speed
  - Average Volume Capacity Ratio (V/C Ratio)
- System Efficiency
  - Travel length
  - Travel time
  - Travel cost
- Environmental Impact
  - Traffic nuisance
  - Traffic accidents
- Social Impact
  - Road Right of way acquisition
  - Relocation of project affected people (PAP)
  - Public acceptance

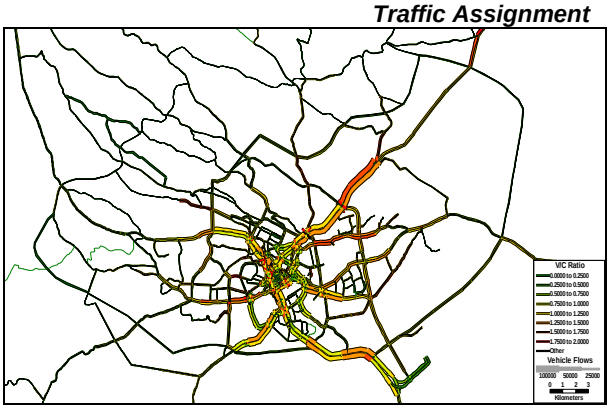
Assumption of Average No. of Passenger and PCU

		Occupancy Rate	PCU (Passenger Car Unit)
Car		1.7	1.10
Bus	Existing	19.0	1.60
	Bus Incentive	24.5	1.75
	Bus Priority	28.0	1.85

Alternative 1: Basic Policy; Traffic Assignment



Alternative 2: Expanded Basic Policy (1); Traffic Assignment

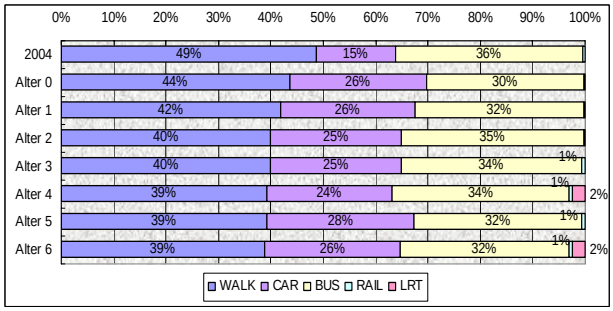


2. Traffic Assignment Analysis

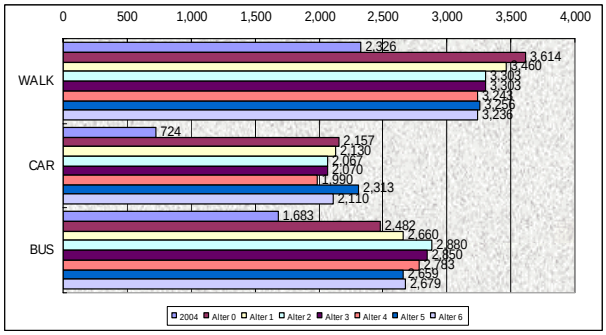
The traffic assignment analysis of six (6) alternatives was made on the proposed transport networks in year 2025 with the modal shares which were assumed as follows:

- Modal shift from walking to private or public mode by implementation of transport policies
- Increased occupancy rate by bus priority policy

Modal Share



Number of Trips by Mode



V/C Ratio 0-1 ; 1221.9km
1-1.5 ; 197.3km
Above 1.5 ; 95.5km

Congested Area (V/C above 1)

- Central
- Embakasi
- Makadara
- Westlands

V/C Ratio 0-1 ; 1360.3km
1-1.5 ; 136.8km
Above 1.5 ; 33.8km

Congested Area;

- None

3. Evaluation of Traffic Efficiency

- The traffic indicators of each alterative were evaluated from the view point of reduction of vehicle trip hours, length and fluidity. As for the reduction of vehicle trip, Alternative 2 shows the highest efficiency of network, followed by Alternatives 3 and 6 which are evaluated as preferable in comparison with Alternatives 0 and 1.
- As for the fluidity of movement, Alternative 6 shows the highest average travel speed and lowest VCR reflecting well formulated expressway network. Alternatives 3, 4 and 5 indicate the formable results, amongst which Alternative 3 is likely to be preferable because of reasonable average travel speed and VCR less than 1.0 without infrastructure facilities of LRT and expressway.
- V/C Ratio on major arterials was further analyzed in both the urbanized and the central area.

As for the road congestion in urbanized area, Alternative 4 shows most desirable forecast results. The average V/C ratio by direction is relatively critical in all alternatives.

As for the road congestion in the central area, the forecast results show different rates compared to those for urbanized area. Most preferable result is obtained by Alternative 6 followed by alternatives 5, 4 and 3.

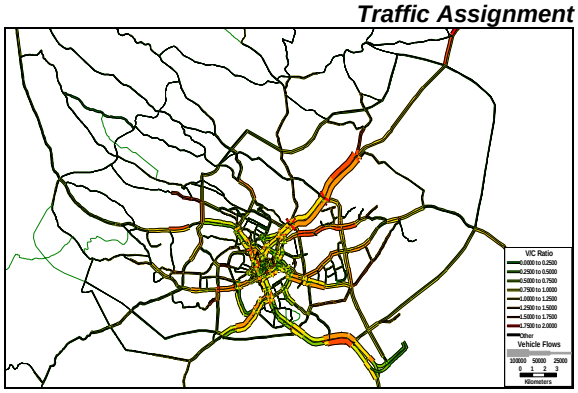
VOLUME – CAPACITY RATIO IN YEAR 2025

Alternatives	0	1	2	3	4	5	6
Urbanized Area							
Radial Roads	1.67	1.11	0.94	0.90	0.88	0.98	0.92
Circumferential Roads	1.69	1.11	0.92	0.87	0.86	0.81	0.75
Total	1.68	1.11	0.92	0.88	0.86	0.86	0.80
Central Area							
Radial Roads	2.19	1.43	1.13	1.09	0.99	0.83	0.75

TRAFFIC INDICATORS OF ALTERNATIVES

	Total Trips (trips/day)	Vehicle-hours Total ('000veh.hours)	Vehicle-km Total ('000veh.km)	Ave. Travel Speed (km/hr)	Ave. V/C Urbanized Area (Radial)	Ave. V/C Urbanized Area (Circumferential)	Ave. V/C Central area
2004	779,774	286	9,935	34.7	0.59	0.68	0.97
Alternative 0	1,933,581	2,484	27,934	11.2	1.67	1.69	2.19
Alternative 1	1,914,054	1,100	24,987	22.7	1.11	1.11	1.43
Alternative 2	1,864,083	717	22,382	31.2	0.94	0.92	1.13
Alternative 3	1,863,804	655	21,751	33.2	0.90	0.87	1.09
Alternative 4	1,806,045	606	20,978	34.6	0.88	0.86	0.99
Alternative 5	2,013,039	680	23,868	35.1	0.98	0.81	0.83
Alternative 6	1,878,875	597	22,195	37.2	0.92	0.75	0.75

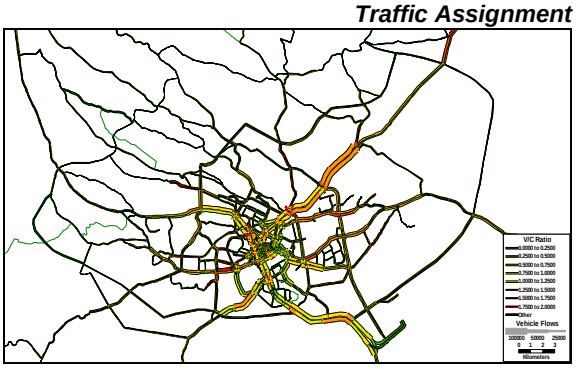
Alternative 3: Expanded Basic Policy (2); Traffic Assignment



V/C Ratio 0-1 ; 1371.8km
1-1.5 ; 152.2km
Above 1.5 ; 22.4km

Congested Area;
- None

Alternative 4: Rail Oriented System; Traffic Assignment



V/C Ratio 0-1 ; 1395.8km
1-1.5 ; 143.4km
Above 1.5 ; 17.2km

Congested Area;
- None

4. Economic Evaluation

The economic evaluation is conducted on B/C ratio and EIRR. The results show that Alternative 3 produces the highest value of B/C ratio and EIRR followed by Alternative 4.

ECONOMIC INDICATORS OF ALTERNATIVE PLANS

	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6
Present Value of Benefit ('000 Ksh)	8,530	32,342	45,856	62,850	58,727	66,855
Present Value of Cost ('000 Ksh)	8,312	11,712	15,408	29,677	37,056	59,928
Rough Net Present Value	218	20,621	30,449	33,173	21,671	6,927
Rough B/C Ratio	1.03	2.76	2.98	2.12	1.59	1.12
Rough EIRR (%)	12.1%	39.4%	42.7%	42.2%	41.3%	17.1%

Alternative 1 shows a scrarcely acceptable level in economic viability, traffic condition, system efficiency and environmental impact because of possible improvement of traffic condition in both the urbanized area and city centre.

Alternative 2 scores almost acceptable level because of the promotion of bus operation, but traffic nuisance will still remain high due to traffic congestion in the city centre.

Alternative 3 is evaluated as highly acceptable in terms of economic viability and traffic condition and fair in system efficiency. The environmental impact is also considered as highly preferable.

Alternative 4 shows almost the same results as Alternative 3 in traffic condition and traffic efficiency but lower overall indicator because of LRT implementation in economic viability.

Alternative 5 is also considered the same as Alternative 3, except traffic congestion in the urban area and additional right of way required for construction of expressway.

Alternative 6 demonstrates the highest score from the viewpoints of traffic condition, system efficiency and environmental impact but scores lower indicators of economic viability and the lowest evaluation in social impact because of huge additional right of way required for construction of LRT and expressway. This means that implementation of this plan is pre-mature at this moment.

5. Environmental Impact

HC, CO and NOx of each plan were estimated. For comparison purpose, the reduction of pollutant emissions from Do-Nothing case were calculated. Alternative 4 shows the highest reduction, followed by Alternative 3.

ECONOMIC INDICATORS OF ALTERNATIVE PLANS

		Do nothing	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6
HC	Amount	7,095	6,347	5,685	5,525	5,328	6,062	5,638
	Reduction from Do-Nothing	-	748	1,410	1,570	1,767	1,033	1,457
CO	Amount	58,661	52,473	47,002	45,677	44,054	50,123	46,610
	Reduction from Do-Nothing	-	6,188	11,659	12,984	14,607	8,538	12,051
NOx	Amount	6,928	6,197	5,551	5,394	5,203	5,919	5,504
	Reduction from Do-Nothing	-	731	1,377	1,534	1,725	1,009	1,424

Notes: Discharge rates are assumed as follows: HC 0.254 g/km, CO 2.10 g/km, NOx 0.248 g/km

COMPARATIVE EVALUATION OF ALTERNATIVES

Alternative	Economic Viability	Traffic Efficiency (Ave. Speed, Ave. VCR)	System Efficiency (Trip Length, Travel Time)	Environmental Impact	Social Impact	Overall Evaluation
Do Nothing		・Not acceptable [E]	・Very bad [E]	・Worse than tolerable [E]	No Change [A]	Not acceptable
Alternative 1	・B/C Ratio=1.03 ・EIRR=12.1% [D]	・Not acceptable [D]	・Bad [D]	・Aggravate traffic nuisance [D]	Relatively Small [B]	Not acceptable
Alternative 2	・B/C Ratio=2.76 ・EIRR=39.4% [B]	・Fairly acceptable [C]	・Fairly good [C]	・Traffic nuisance [C]	Relatively Small Relocation [C]	Fairly acceptable
Alternative 3	・B/C Ratio=2.98 ・EIRR=42.7% [B]	・Acceptable [B]	・Good [B]	・Air pollution improved [A]	Relatively Small [B]	Acceptable
Alternative 4	・B/C Ratio=2.12 ・EIRR=42.2% [D]	・Highly acceptable [A]	・Good [B]	・Traffic nuisance improved [A]	Large Acceptable [B]	Not acceptable because of low system efficiency
Alternative 5	・B/C Ratio=1.59 ・EIRR=41.3% [D]	・Highly acceptable [A]	・Good [B]	・Traffic nuisance improved [A]	Large Relocation [D]	Not acceptable because of high investment
Alternative 6 ・LRT	・B/C Ratio=1.12 ・EIRR=17.1% [E]	・Highly acceptable [A]	・Very good [A]	・Traffic congestion improved [A]	Large Relocation [C]	Not acceptable because of high investment

Note: A; Very Good, B; Good, C; Fair, D; Bad, E; Very Bad

(4) Optimum Transport Master Plan

- Alternative 3 is recommended as the optimum plan based on the evaluation of traffic condition, system efficiency, environmental impact, social impact and economic analysis.

- Alternative 3 is composed of
  - R/C Road Network (2) including Planned Projects
  - Bus Incentive and priority measures
  - Upgrading of existing rail as commuter rail
  - Improvement of Uhuru Highway, Stage I as Expressway.

- Alternative 3 requires the total investment cost of Ksh 43.6 Billion within 20 years.

Roughly Estimated Cost (Unit: MKsh)

Plan Component	Cost
1) Road Improvement	34,795
Bypass and Link	7,971
Missing Links	6,059
Radial Roads	12,400
Circumferential Road	1,452
Others	6,913
2) Public Transport	8,100
Bus	2,300
Rail	5,800
3) Traffic Management	350
4) Traffic Institution	200
TOTAL	43,445

Major Components

Sector	Projects	Unit	Total
Road Network	1. Bypass and Link		
	1) Bypass Roads	Km	85.0
	2) Link Roads	Km	24.4
	3) Link Road Extension	Km	9.4
	2. Missing Links		
	1) Arterial Roads	Km	19.6
	2) Collector	Km	8.1
	3) Local Road	Km	5.1
	3. Radial Roads		
	1) Inside C-3	Km	21.9
	2) C-3 South & West	Km	51.1
	3) C-4 North & East	Km	54.2
	4) New Radial Road	Km	10.9
	4. Circumferential Roads		
	1) C-1 & C-2	Km	10.0
	2) C-3	Km	6.0
	5. Secondary Arterial	Km	65.3
	6. Intersection Improvement	No.	48
	7. Non-Motorized Transport	Km	59.8
	8. Uhuru Highway Improvement		
	1) Widening	Km	3.7
	2) Grade Separation	No.	7
	Sub-Total		395.6
Public Transport	1. Bus Incentive Policy	Set	1
	2. Bus Priority Policy	Set	2
	3. Existing Rail	Set	3
	Sub-Total		6
Traffic Management	1. Traffic Circulation in City Centre	Set	1
	2. On Street Parking	Set	2
	3. Traffic Enforcement	Set	1
	4. Public Education	Set	1
	Sub-Total		5
Traffic Institution	1. Human Resource Capacity Building	Set	1
	2. Institutional Development	Set	1
	Sub-Total		2

Recommended Transport Master Plan: Alternative 3