UNIVERSITY OF NAIROBI

ROAD MAINTENANCE IN NAIROBI COUNTY

Presented by: NJERI VICTOR KAMAU

F16/36482/2010

Supervisor: Eng. G.P.K. MATHERI

A project submitted as partial fulfillment for the requirement for the award of the degree of

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

2015

ACKNOWLEDGEMENT

In preparing this project report, I was in contact with many peoples, researchers, academicians and practitioners. They have contributed towards my understanding and thought. In particular, I would to express my sincere appreciation to my project supervisor Eng. G.P.K. Matheri, for encouragement, guidance, critics, motivation and friendship. Without his support and interest, this research would not have been the same as presented here.

I am also thankful to the officers of from the different agencies involved especially Eng. Monica Abonyo, Eng. Andrew Amayi, Eng. Timothy Karanja regional mangers KeNHA, KURA and KeRRA respectively for the cooperation and experience shared.

My sincere appreciation also extends to my family, my colleagues and others who have provide assistance at various occasions; their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space

DEDICATION

This project is dedicated to my mother and my family at large who have been there at all times to provide much needed support in life

ABBREVIATIONS AND ACRONYMS

GoK-Government of Kenya

MoR-Ministry of Roads

KeNHA-Kenya National Highways Authority

KURA Kenya Urban Roads Authority

KeRRA-Kenya Rural Roads Authority

KFS-Kenya Forestry Service

Km-Kilometres

KRB Kenya Roads Board

KWS Kenya Wildlife Service

CRC-Constituency Roads Committee

LB-Labour Based

LBT-Labour Based Technology

M&E-Monitoring and Evaluation

R2000-Roads 2000

RMLF-Roads Maintenance Levy Fund

A**PRP**-Annual Public Roads Programme

SADC-South African Development Community

RFA-Roads fund administration

RA-Roads Authority

RCC-Roads Contractor Company

Ksh.-Kenya shilling

ABSTRACT

Road should be viewed as an important national assets. Like any other assets, road must be regularly maintained to keep them serviceable. The study conducted on the Nairobi County, whereby there were agencies involved to specifically to manage and maintain the road assets.

The aim of this study is to study road maintenance system in Nairobi County; identify the common problems in road maintenance and financial trends already in place. This was informed by the government agencies involved in maintenance including; Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA), Kenya Urban Roads Authority (KURA), Nairobi City County Government as well as their maintenance work programmes

The study is carried out through discussions, obtaining relevant information and sample roads were taken. The discussions were conducted with the personnel involving in road maintenance management. Information obtained included maintenance funding budget for previous years was obtained from the Kenya Roads Board, disbursement criteria of the funds to be given to various road agencies, proposed maintenance budget and the approved maintenance budget and the unit costing. Sample roads were selected for better analysis of the information obtained from the agencies. One road per agency was selected. Site visit was conducted to ascertain the works done.

Proposed maintenance budget and the approved maintenance budget were compared and there was disparities observed. From the unit costing, it was observed that the resources available were not enough. Discussions were also conducted with the Engineer. These discussions helped to clarify any information obtained. Site visit was conducted to ascertain the works done and some challenges faced on site were identified.

On the basis of the findings in this study, the recommendations were made to improve the road maintenance in Nairobi County.

TABLE OF CONTENTS

CHAPTER ONE

1.0 INTRODUCTION

1.1 General

Maintenance is always a must for any structure in order to maintain its serviceability and to prevent deterioration that may shorten the service life. In reality, maintenance works are not given the attention it should have budget allocated for maintenance work in which seldom become a prior consideration. However, it is a fact that maintenance is the most important and the activity to be carried out to prolong or at least maintain serviceability of structure until the end of its service life. [1]

Structures as stated do not solely refer to buildings. Other structures such as bridges, roads, harbours, drainages and any kind of engineering structures are also included. Maintenance on these structures may differ in various ways, but all of it must be carried out in a strategic and systematic way. [1]

1.2. Background

The key driver to development of any nation is the road infrastructure. With the country vision 2030, it envisages a country interconnected with network of roads, railways, ports, airports, water ways and telecommunications as well as adequately provided with energy. Road transport is the predominant mode of travel carrying over 90% of cargo and passenger-traffic in the country. [2]

At independence Kenya had a road network was about 45,000km out of which only approximately 2000km were paved while the rest was mainly earth. In order to support the country's development objectives the country embarked on an ambitious program of upgrading roads to bitumen standards and improvement of rural roads to gravel standards. As a result, the paved road network was expanded from 2000 km in 1963 to 11,189 km in 2009. [2]

In 2001, the Ministry of Roads, with financing from World Bank, engaged a Consultant to undertake a Road Inventory and Condition Survey (RICS) for the Classified Roads using Geographical Positioning Systems. The RICS study led to the establishment of a database for classified roads in a Geographical Information System. [2]

Unfortunately, the extent of the unclassified rural and urban roads remained unknown and was estimated to range from 80,000 to 130,00km making it difficult for effective maintenance and

development planning. The responsibility for the management of the road network falls under the Ministry of Roads and implemented through Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA), Kenya Urban Roads Authority (KURA) and Kenya Wildlife Service (KWS). [2]

Road transport is increasingly becoming the main mode of travel for goods and passengers in the country. This can be mainly attributed to lack of integrating all other modes of transport to complement each other. By 1996, the urban road network was about 6000km of which only 2000km were paved, about 36% of all urban roads being found in Nairobi alone. However, there is a major problem in Kenya's road sector resulting from poor quality of roads countrywide. [2]

The responsibility of road maintenance was done by the national government in conjunction with the local authorities since 1968 after it was found out the roads were deteriorating due to vehicle overloading and also inadequate road maintenance by local authorities. To remedy the situation, the government assumed full responsibilities of road maintenance of the entire classified road network. This resulted to road network improving considerably until 1975 when it began to decline again mainly due to insufficient funds allocated. This in turn meant that periodic and routine had to be cut down substantially. [2]

Today, road maintenance is carried out by the road agencies under the ministry of roads and public works. Kenya Urban Roads Authority (KURA) maintains the major thoroughfares through the city but only from the city's outskirts toward the rural areas where its maintenance domain really is. Kenya Rural Roads Authority (KeRRA) on other hand is also responsible for the maintenance of other roads within the city. This is however subject to change as roads function was devolved to county governments through the new constitution. [2]

1.3 Problem statement

Road maintenance is essential in order to preserve the road in its originally constructed condition, protect adjacent resources and user safety, and provide efficient, convenient travel along the route. Unfortunately, maintenance is often neglected or improperly performed resulting in rapid deterioration of the road and eventual failure from both climatic and vehicle use impacts. It follows that it is impossible to build and use a road that requires no maintenance.

1.4 Objectives and scope of study

To achieve the aim of this study, the following objectives have been set:

1) To study the road maintenance system in Nairobi County, identify the common problems in road maintenance and financial trends already in place; and

2) To recommend the ways of improving road maintenance.

The scope covered roads managed under Nairobi City County. This was informed by the government agencies involved in maintenance including; Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA), Kenya Urban Roads Authority (KURA), Nairobi City County Government as well as their maintenance work programmes.

1.5 Study methodology

The study was carried out through discussions with the personnel involving in road maintenance management, obtaining information from the agencies and sample roads were taken. Information obtained included maintenance funding budget for previous years was obtained from the Kenya Roads Board, disbursement criteria of the funds to be given to various road agencies, proposed maintenance budget and the approved maintenance budget and the unit costing.

Sample roads were selected for better analysis of the information obtained from the agencies. One road per agency was selected. Site visit was conducted to ascertain the works done.

1.6 limitations of the study

This study's limitation was centred on collecting of adequate information on road maintenance on Nairobi County, with some agencies withholding information. Information on expenditure could not be obtained.

CHAPTER TWO

2. LITERATURE REVIEW

2.0 INTRODUCTION

The purpose of literature review was to study the theoretical background on about Road Maintenance through the journals, books, references, internet and articles. The study was related to the aim and objectives of this study. This chapter discusses on the definition of maintenance, function and value of maintenance, the road and its elements, types of road maintenance, pavement evaluation, and maintenance of roads, road classification in Kenya, institutional framework and maintenance funding. Also case studies was done.

2.1 DEFINITION OF MAINTENANCE

Maintenance consists of a set of activities directed toward keeping a structure in a serviceable state. For pavement, this includes such work as patching, crack, filling and so on. Following are some definition of maintenance from different sources. [3]

i. Definition from BS3811: 1984 describes maintenance as combination of technical and management work done on a specific asset or structure to ensure the structure is in good condition and is functioning at its maximum capacity. They are two types of maintenance:

- Maintenance involving repairing work
- Maintenance involving prevention work.

Reparation can be described as rehabilitation or replacement of spoiled components meanwhile prevention is to prevent defects from occurring.

ii. Definition from Oxford Advance Learner's English Dictionary describes maintenance as the action of maintaining something or the state of being maintained.

iii. From Majdi, *et al* (2002), definition of pavement maintenance can be described as methods and techniques used to restore or maintain a specified level of service and to prolong pavement life by slowing its deterioration rate.

As a summary, the main and only objective of maintenance is to ensure the specific structure being maintained is in a good and acceptable condition and will not cause inconvenience to the users.

2.2 FUNCTION AND VALUE OF MAINTENANCE

The effectiveness of a maintenance system or work can be assessed through the performance of structure before and after maintenance. The best person to do the assessment will be the users themselves because only users will feel the differences and therefore can comment on the performance of the specific structure. [3]

2.2.1 Function of maintenance

Maintenance works are done to achieve desired goals determined during stages. The main functions in maintaining the roads in a condition that gives good service and maximum safety to the travelling public. This is achieved by keeping the road free of disconcerting physical defects such as potholed pavements, broken pavement edges, loose gravels, stick surfaces, loose and defective bridges decks and other imperfections. [3]

2.2.2 Value of maintenance

A pavement or any other structure will last longer with proper and continuous maintenance. Poor maintenance may result in the need for reparation, renovation or reconstruction, which will increase cost at the end of life cycle of the structure. The value of maintenance is discussed from the aspect of: [3]

i. Time

Compared to time required for reparation and renovation on a structure, maintenance consumes less time, but can produce better quality results. Besides, work qualities for maintenance are also relatively lesser compare to reparation and renovation.

ii. Cost

Definitely the costs required by maintenance are lesser then cost required to repair or to rebuild a structure. Furthermore, a specific structure can still be running under maintenance hence saving cost from the economic perspective. For example, closing a runway is a must for resurfacing, will lower that can be generated during that period.

iii. Structure value and performance

Structure will have high value and good performance during its service life if maintenance works are done according to schedule and plan. Without proper maintenance, a structure will not be able to provide services at its maximum performance all the time.

2.3 THE ROAD

A road can be defined as a thoroughfare, route or way on land between two places, which has been paved or otherwise improved to allow travel by some conveyance including a horse, cart, or motor vehicle. Road consist of one or sometime two road ways each with one or more lanes and also any associated sidewalks and road verges. Roads that are available for public use are referred as public roads or highways. [6]

2.3.1 Road Surface Types.

There are five basic surface types in the context of maintenance and can be defined as: [7]

(1) Paved Surface. All types of asphalt pavement and Portland cement concrete pavement.
(**2) Gravel Surface**. All aggregate-surfaced roads, using crushed, screened or pit-run materials that have a minimum depth of 2". This includes roads with aggregate base or sub-base that will remain at this stage for one year or more.
(3) Improved Earth Surface. Roads whose surface consists of the same type of material as the roadway foundation. These include graded and drained roadways that will remain at this stage for more than one year. Also included are roads where the aggregate has been lost. These roads are single or double lane, with limited surfacing and they have surface crowns, ditches and culverts. These roads are not all-weather roads.
(4) Unimproved Earth Surface. Roads whose surface consists of the same type of material as the roadway foundation. They include bulldozed trails without surfacing or culverts and are considered for seasonal use only, due to budget constraints.
(5) Paths and Walkways. Displaced rights-of-way with paved or unpaved surfaces which are limited to pedestrian and/or non-motorized vehicle use

2.3.2 Road elements and deterioration

A road is made up of different parts or elements. Apart from the road surface, which people drive or walk over, many other elements support the road and protect it from damage. The most important road elements are as discussed. [8]

Road surface. It is the main element of the road; the road surface supports the traffic driving on it. For unpaved roads, the surface can be made of earth, gravel, or stone pavement. Unpaved road surfaces can be damaged by water flowing over them, causing erosion and muddy areas. Traffic also causes damage, especially if there is water on the road, resulting in ruts and potholes. If such damage is severe, the road becomes impassable.

Road shoulder. The road shoulder gives additional support to the road surface, especially in the case of stone pavement, separating the road surface from side drains and slopes. Road shoulders can also be damaged by water and traffic, leading to decreased support for the road surface and possibly its collapse. In the case of stone-paved roads, damaged road shoulders can cause the stones to become loose.

Side drain. It guides water along the side of a road and safely away from it, so the water does not flow over the road surface where it may cause damage. They form the most basic protection for the road. Side drains can become silted up or blocked by landslides or vegetation. Where this happens, water no longer flows through the side drains but flows over the road, causing damage.

Culvert. It allows water to cross safely under the road through a pipe, so water does not flow over the road surface where it may cause damage Culverts can become blocked by sediment and vegetation, causing water to flow over the road surface instead, leading to damage.

Bridge. is used where the amount of water crossing under the road is too much for a culvert and a bigger opening is needed Bridges can also become blocked with vegetation and material left behind by water. Where this is severe, water can no longer flow under the bridge, so it flows over it or over the road, causing damage.

Slope. Where a road crosses a mountainous area, it is necessary to cut into the mountains. This results in cut-slopes uphill from a road and fill-slopes downhill from a road. These must be stable to avoid damage to and blockage of the road. Slopes can collapse, especially where water flows over them and there is no wall or vegetation to stabilize them. This causes landslides, which may block the road and side drains. The flow of water can also cause cuts in the road shoulder, which can undermine the road.

Retaining wall. Where slopes are not sufficiently strong, a retaining wall can be used to stabilize them. A retaining wall can be made of loose, piled stones; cemented stones; or stones in a wire cage (also known as a gabion). Retaining walls can become damaged and even collapse. This will limit the support that they give to the slopes and shoulders, resulting in landslides or road collapse.

2.3.3 Categories of road maintenance

For management and operational convenience, road maintenance is categorized as routine, periodic, and special. [9]

Routine maintenance, which comprises small-scale works, conducted regularly, aims "to ensure the daily passability and safety of existing roads in the short-run and to prevent premature deterioration of the roads". Frequency of activities varies but is generally once or more a week or month. Typical activities include roadside verge clearing and grass cutting, cleaning of silted ditches and culverts, patching, and pothole repair. For gravel roads it may include re-grading every six months. [9]

Periodic maintenance, which covers activities on a section of road at regular and relatively long intervals, aims "to preserve the structural integrity of the road". These operations tend to be large scale, requiring specialized equipment and skilled personnel. They cost more than routine maintenance works and require specific identification and planning for implementation and often even design. Activities can be classified as preventive, resurfacing, overlay, and pavement reconstruction. Resealing and overlay works are generally undertaken in response to measured deterioration in road conditions. For a paved road repaving is needed about every eight years; for a gravel road re-graveling is needed about every three years. [9]

Special/Urgent maintenance is undertaken for repairs that cannot be foreseen but require immediate attention, such as collapsed culverts or landslides that block a road. [9]

It should be noted that maintenance does not include rehabilitation, building shoulders, or widening roads. If the sections to be rebuilt constitute more than 25 percent of the road's length, the work is rehabilitation, not maintenance. [9]

2.4 ROAD MAINTENANCE MANAGEMENT SYSTEM (RMMS)

A Road Maintenance Management System (RMMS) is a maintenance management process aimed at systematically and objectively determining pavement quality and programming maintenance actions in response to observed conditions, budgetary constraints and economic optimization (reduction of user costs, optimizing agency maintenance cost). The RMMS is a tool which provides assistance to the maintenance engineer for maintenance programming, implementation and monitoring. [10]

The major objectives of a Road Maintenance Management System are the following:

i. Provide the economic and managerial framework for deciding the optimal level of maintenance funding and the optimum level of pavement condition nationwide in both the long-term and short-term perspectives;

ii. Provide sound methods for developing annual works programmes and determine resource requirements and budgets;

iii. Allocate funds in a rational and optimized manner to the various maintenance tasks and administrations, particularly under budgetary constraints;

iv. Schedule and perform the work;

v. Monitor the efficiency and effectiveness of the works carried out; and

vi. Evaluate the consequences of delaying or postponing maintenance on future budget needs and the future deterioration of pavement condition.

2.4.1 Problems in road maintenance management system

RMMS related issues and expected outputs can be grouped in three levels namely; legislative level, administrative level and technical level. [11]

- **Legislative Level Issues**

The legislative level issues are fairly broad in scope and must be recognized by the administrative and technical levels. They include; justification of budget request, effects of less capital and maintenance funding, effects of deferring work or lowering standards, effects of budget request on future status network; and effects of increased load limits. [11]

- **Administrative Level Issues**

The administrative level issues are related to the decision making process including budget and programming priorities. These issues include; an objectively based priority program to provide justification for budget requests, a summary assessment of the current status of the network, in graphical and tabular format, based on inventory measurements, the means for quantitatively determining the effects of lower budget levels, and the budget level required to keep the network in its present state. Additionally means for quantitatively demonstrating the effects of deferring maintenance or rehabilitation and estimates of the future status of the network (in terms of average serviceability, condition, safety) for the expected funding. [11]

- **Technical Level Issues**

From a technical perspective, pavement management involves a large number of issues and questions. In addition, the question and issues faced at the administrative level must be appreciated if technical activities are to be meaningful.

The following are some of the key questions for this level, involving both network and project considerations: Inventory database design and operation, methods and adequacy of inventory database, models for predicting traffic, performance, distress, skid, among others, their

reliability, consistency, reasonableness, deficiencies, models for priority analysis and network optimization and Verification of models. [11]

2.4.2 Improving road maintenance management system

Every system which is practicing now has their strength and weakness together with the improvement in technology. So, for the Road Maintenance Management System was not excluded and need to improve the system time by time. A systematic approach to maintenance management is needed for several reasons including to provide information on the current state of pavements and forecast future condition; to give objective alternatives for maintenance policies; to provide a sound basis for resource allocation and optimal use of funds; to increase the effectiveness of management and provide savings in expenditure; and to provide an objective, rapid and repeatable system for decision making. [11]

2.5 PAVEMENT EVALUATION

Pavement evaluation is a technique of assessing the condition of a pavement, both structurally and from the point of view of surface characteristics. It is also known as pavement condition survey and rating of pavement. [20]

Pavement evaluation is a handy tool in the hands of a highway engineer and serves a variety of purposes, such as to Research on the performance of pavements of different specifications over a period of time, to assess maintenance needs such as patch repairs, renewals and reseating and to assess the need for structural overlays on distressed pavements. [20]

2.5.1 Methods of Pavement Evaluation

The methods available for pavement evaluation are:

2.5.1.1 Visual Rating

Visual rating is used method of inspecting the pavement surface for detecting and assessing the amount and severity of various types of damage. The usual manifestation of distress or damage occurs in the form of: Rutting, corrugations, ravelling, flushing, alligator cracking, and extent of repairs, longitudinal cracking and transverse cracking. [20]

There are various methods of visual rating in use by different organizations the world over. One of the most widespread methods was initially developed at the Texas A and M University and is commonly known as the Deduct Value or Deduct Point method. In this method, certain

deduct points are associated with specific values of various distress factors. The deduct points indicate the relative importance of the distress type. These deduct points are then subtracted from an established "perfect" score (usually 100) to arrive at the overall rating score of the pavement. [20]

2.5.1.2 Present Serviceability Index (PSI)

Present serviceability index is a statistical estimate of the mean of the present serviceability ratings given by the panel

PSI = 5.03-log (1 + SV)-1.38(RD) 2 -0.01(C + P) 1/2

Where

SV = Slope variance over section from CHLOE Profilometer (slope variance was an early roughness measurement)

RD = mean rut depth (in.),

C = cracking (ft / 1000 ft^2) (flexible),

P = patching (ft2 / 1000 ft^2).

It is one of the major contributions of the AASHO Road Test was the development of a rating system involving the measurement of permanent deformation, riding quality and the extent of cracking and patching. The rating is well-known by the term Present Serviceability Index (PSI) and is probably the most widely used pavement rating measure in existence today. [20]

2.5.1.3 Roughness Measurements

The riding quality of a pavement is determined to a large extent by its structural adequacy, the traffic load repetitions it has been subjected to the specifications adopted for the surfacing initially and the maintenance inputs. Hence a measure of the pavement performance can be obtained by monitoring its roughness. [20]

2.5.1.4 Benkelman Beam Deflection

An evaluation of the structural performance of flexible pavements can be obtained by the Benkelman Beam Deflection method. The Lacroix deflectograph serves the same purpose. Pavement sections, which have been subjected to traffic deform elastically under a load. The elastic deflection depends upon various factors, such as; Sub grade soil type, moisture content and compaction of sub grade soil, pavement thickness, composition, quality and condition, drainage conditions, pavement surface temperature and wheel load. [20]

The Benkelman beam and the Lacroix Deflect graph measure the deflections under standard wheel load conditions. Two kinds of deflection measurements are possible: [20]

1. Rebound deflection, which is the recoverable deflection or the elastic deflection. In a well-designed road, the deflection is entirely elastic and recoverable.

2. Residual deflection, which is the non-recoverable deflection. As a pavement ages, it loses a portion of its elastic properties and a permanent deflection takes place.

The Benkelman beam is a handy instrument which is most widely used for measuring deflection of pavements

2.5.1.5 Skid Resistance Surveys

A smooth surface is dangerous to traffic, especially when the surface is wet and the vehicles move fast. While care is normally taken to construct reasonable skid-resistant surfaces, the passage of vehicles polishes the aggregates. Excess bitumen tends to fatten the surface and render it slippery. An evaluation of the skid resistance of the surface at periodic intervals is needed to ensure that the roughness level has not fallen to dangerously low levels. This is accomplished by measurement of skid-resistance periodically. [20]

2.5.2.6 Pavement Deterioration Research

Pavements deteriorate due to traffic and environmental factors. The extent of deterioration is also a function of the initial pavement thickness and composition. The exact way in which a pavement deteriorates is of great importance to a maintenance engineer to work out the maintenance strategy and to a highway planner to work out the economic evaluation of schemes. Interest in this field is, therefore, increasing the world over. [20]

A recent development in the field of pavement research and evaluation is the Heavy Vehicle Simulators (HSV). This machine is capable of applying wheel loads of upto 100KN through a dual or single wheel assembly on a pavement, and can apply upto 1400 repetitions of load per hour. Thus, upto half a million repetitions of load can be applied to a pavement in 20 to 30 days. This equipment can, therefore, save considerable time in testing a pavement under actual traffic. [20]

2.6 ROAD INVENTORYING

Road inventorying is a systematic procedure of collecting details of existing roads. It serves a variety of purposes, such as: [20]

• Assessment of deficiencies in the existing system in regard to land width, cross-sectional elements, geometries, surface type, riding quality, cross-drainage structures, traffic signs, pavement markings. Such an assessment will facilitate planning of improvements, fixation of priorities and allocation of resources.

• Assessment of maintenance needs with knowledge of accurate road length, pavement width and specifications, terrain, rainfall intensity etc.

• Assessment of the hydraulic and structural adequacy and carriageway width of cross-drainage structures, with view to plan for their improvements.

A road inventory which is out-of-date is not of much use. It therefore has to be updated at periodic intervals. An interval of **5** years is considered satisfactory.

2.6.1 Manual Methods of Inventorying

Manual methods of inventorying involve engineering surveys of alignment, vertical profile, and other physical measurements. They are tedious and time-consuming and represent large manpower requirements. In view of the difficulties involved, they cannot be routinely carried out and require special effort. [20]

2.6.2 Instrument-Aided Inventorying

Since manual method of road inventorying is tedious, instrument aided methods are now being followed. This is normally accomplished by an instrumented car containing the following: [20]

• An accurate distance measuring device, actuated from the Speedo-cable of the car, having an accuracy of 20m.

• A gyroscope for measuring horizontal curvature, which takes the direction readings at the beginning and the end of each horizontal curve, along with the corresponding distance readings. The deflection angle and radius can thus be computed from these readings.

• A gradometer, for indicating the per cent upward or downward gradient as the car moves along.

• A car-mounted bump-integrator which gives the roughness reading for each kilometre. In addition to the above readings, the observer in the car can also record the terrain, pavement surface type, urban or rural sections, shoulder type and location of junctions and their type.

The above data can be supplemented by manual data collection on details of cross-drainage works.

2.6.3 Computer-Aided Road Data Bank System

The storage and retrieval of data is rendered easy if computer-aided Management Information System is adopted. Apart from storing the road inventory data, the data bank can also include traffic census data, particulars of maintenance inputs (renewals, resurfacing), soil particulars, drainage aspects

2.7 ROADS MAINTENANCE

2.7.1 Maintenance of highways

A highway facility deteriorates in its characteristics due to various causes which can be divided into traffic factors and environmental factors.

Traffic Factors: The traffic operating on the facility causes ravelling, rutting, corrugations, cracking, loss of material, loss of skid-resistance and structural deformation. The extent of deterioration depends upon the intensity of traffic, especially the wheel load and its repetitions. Iron-wheeled traffic can be significance in the case of water-bound macadam roads and earthen roads.

Environmental Factors: The external influence of environmental factors such as rainfall, snowfall, temperature variation and atmospheric conditions can cause deterioration of the pavement. Rainfall causes erosion of shoulders and slopes and ingress of water into the pavement structure and subgrade and affects the performance of drainage structures. Snowfall can cause ingress of moisture into the pavement structure and subgrade and result in frost action. It can also disrupt traffic.

Temperature variations can soften the binder and affect the performance of bituminous surfaces and cement concrete pavements Atmospheric action can oxidise the binder and cause deterioration.

In addition to the above, the extent of deterioration and its rate are governed by the standards to which a facility was designed initially If a facility is designed to higher standards initially, its maintenance needs will be lower than if it is designed to lower standards initially.

The economic benefits of a well-planned maintenance policy includes reduction in road user costs, such as vehicle operating costs, travel time savings and accident costs. Reduction in the level of future maintenance and rehabilitation costs and Reduction or prevention of the economic loss due to road closures.

From the above, it is clear that a good policy of highway maintenance should be one of the aims of any highway department.

2.7.2 Assessing Maintenance Needs

Till recently, the assessment of maintenance needs was done by intuition and past experience of the highway engineer. He used to travel on his roads, visually Inspecting the condition of the surface and its extent of deterioration. The travel in inspection vehicles used to enable him to judge the riding quality, his accumulated experience used to guide him in determining the periodicity and specifications for resurfacing and resealing.

While in Kenya the above system is still in vogue, in the advanced countries great strides have been recently made in assessing maintenance needs on a more scientific and exact basis. The steps Involved in such a system are:

1. Evaluation of the pavement characteristics by various methods.

2. Development of minimum standards for road characteristics like roughness and skid resistance.

3. Provision of the needed maintenance inputs based on (1) and (2) above at appropriate periodicity.

The selection of minimum standards for maintenance can be scientifically done if research is conducted on the deterioration of road characteristics over a period of time under traffic and the road user costs under different levels of road characteristics. The most common road characteristic used for this purpose is roughness. It is generally observed that a road deteriorates in its roughness over time under traffic, due to cracking, ravelling, rutting, deformation etc. When the deterioration reaches such a level that the road user costs mount up, it is advisable to resurface the road and restore it to its original condition

2.7.3 Maintenance of Earth Roads

Earth roads form a major percentage of rural roads in Kenya and hence their efficient maintenance is of great importance. Because of the low specifications (inadequate embankment height, small roadway width and low cost drainage arrangements), good maintenance can preserve the assets and prolong their life. [20]

The principal maintenance operation consists of maintaining the cross-section by grading and dragging.

Grading: The shaping and sectioning of an earth road is best done by blading with a grader or motor grader. A grader of about 110 HP is suitable for the purpose. In Kenya, it is most unlikely that mechanical graders are available for routine maintenance operations. Manual methods should include making up ruts and deformations by additional soil from borrow pits and restoring the camber. If iron-tyred traffic is heavy and ruts are formed, the ruts can be rilled by quarry rubbish, gravel or other inferior local materials. [20]

Dragging: Dragging stops the formation of corrugations. A typical drag, which can be towed by animal power, by men or by motor grader [20]

Rolling: the earth surface should be rolled and compacted after grading and dragging. A light sprinkling of water can be done if rolling is done in dry season. [20]

Filling of rain-cuts: Rain-cuts in the embankment slopes should be filled up after the rainy season. Turfing prevents rain erosion. [20]

2.7.4 Maintenance of Gravel Roads

Gravel roads (murram roads) are very common in Kenya. The maintenance operations involved are filling local depressions, grading, dragging, rolling and re-gravelling. [20]

Filling local depressions: Local depressions and longitudinal ruts should be filled up by adding fresh materials of the same specifications as the original material. Light sprinkling and tamping with hand rammers will help in compacting of the material. [20]

Grading: It is an operation intended to restore the camber and shape of the gravel surface. A motor-grader is ideal for this purpose. For gravel roads, heavy grading is inadvisable without the provision of additional surfacing material if the remaining thickness of gravel is less than 75mm. [20]

Dragging: One of the common defects that develops in a gravel road is corrugations. Dragging can stop the formation of corrugations. [20]

Re-gravelling: Re-gravelling is necessary to make up for the loss in material caused by the combined action of traffic, rain and wind. The loss per year is about 25 mm thickness. Re-gravelling is done once in2-5 years. Additional gravel, 25-75 mm loose thickness is spread after scarifying the old surface. Water is sprinkled to facilitate compaction which is done preferably at optimum moisture content. The layer is rolled by a power roller. [20]

2.7.5 Maintenance of Water-bound Macadam Roads

Untreated water-bound macadam is a common specification. Water-bound macadam surface deteriorates in the following typical ways including the formation of ruts, potholes, corrugation, ravelling and damaged edges. [20]

Formation of ruts is caused by excessive camber and preponderance of iron-tyred traffic. Ruts are made good by rut-renewal, which consists of cleaning and watering the rut, scarifying and removing the stones to an approximately rectangular section with fiat bottom and vertical sides, Filling the section with salvaged metal and fresh metal, rolling with the addition of screenings, gravel and watering, and finally spreading 6 mm sand layer. [20]

Pot-holes are formed due to lack of binding properties in the binder material, poor quality of stones, local sub-grade failure or defects in consolidation. Pot-holes are remedied by patch repairs; the area to be patched is cut to a rectangular or square shape with vertical sides. The sequence of operations for laying patch material is the same as in rut renewal. Hand rammers can be used for patch repairs instead of power rollers. [20]

2.7.6 Maintenance of Bituminous Surfaces

A bituminous surface wears out due to: traffic, weather, such as ingress of water, loss of volatiles in the binder and oxidation of binder inadequacies in the initial specifications and construction standard. [20]

Pot-hole repair: The amount of patching needed to make up pot-holes and localized failures may vary from 0-25 per cent of the surface area annually. Patching prolongs the surface life

until a time will come when it will be more economical and desirable to renew the surface entirely. [20]

Patching can be done by sand premix, open-graded premix, dense-graded premix penetration patching or surface dressing. [20]

Dense-graded premix patch is rarely used and only where the existing surface itself is dense-graded asphaltic concrete. Surface dressing (one or two coats) can be done for existing surfaces with a similar specifications and where the traffic is not too heavy. [20]

Patching consists of the following sequence of operations: [20]

1. Cleaning the area by brooms.
2. Trimming the sides vertically and the shape to a rectangle or square and levelling the bottom.
3. Painting the sides and bottom of the hole with a tack coal if a premixed material is used.
4. Following the regular specifications of the treatment.
5. Rolling or hand tamping and checking the profile with straight edge.

Surface Re-sealing: Sealing the surface is resorted to rectify hungry surface, repair cracks, and arrest loss of aggregates. Sealing can take the form of liquid seal, fog seal or slurry seal.

Liquid seal is an application of a binder (penetration grade or emulsion) at 9.8 kg/10 sq m followed up with a spread of cover aggregates, 6.3 mm nominal size, at a rate of 0.09 cu m/10 sq m and rolling in position. [20]

Fog seal is a spray of slow-setting emulsion diluted with equal amount of water at a rate of 0.5-1 litre sq m. Traffic is allowed after the seal sets in. It is provided over a hungry surface, a cracked surface, a surface where there is loss of aggregates and over a surface exhibiting ravelling. [20]

A slurry seal is the application of slurry composed of slow-setting emulsion, water and aggregates to a thickness of 5-10 mm. The emulsion and water are 18-20 per cent and 10-12 per cent respectively of the weight of aggregates. The slurry is spread at the rate of 200 sq m per tonne. No rolling is needed. Slurry seal is provided over a hungry surface, cracked surface, a surface where there is loss of aggregates and over a surface exhibiting ravelling. [20]

Because of low viscosity of the binder, the specification results in sealing voids and cracks. [20]

2.7.7 Maintenance of Cement Concrete road

A well designed and properly constructed cement concrete pavement hardly needs any maintenance. In fact, this is one of the strong points of this specification. However, defects do appear due to ingress of water to the subgrade causing uneven settlement especially through joints and/or inadequate design and faulty workmanship. [20]

Cracks: The common defect noticed in a cement concrete slab is the appearance of cracks. Cracks can be shrinkage cracks, structural cracks, contraction cracks, corner cracks and warping cracks. They can be of varying width. [20]

Usually hair cracks are not dangerous since they do not admit water to the subgrade. Medium and wide cracks are harmful since they can cause progressive destruction of the subgrade support by allowing water to percolate. Cracks are filled up by liquid substances such as bituminous emulsions, cutback bituminous or joint sealing compounds, whose basic ingredient is bitumen. Before the cracks are sealed, they are cleaned of dust and foreign matter. [20]

Compressed air jets and nozzles are useful to achieve this. The dry joints are then filled with appropriate bituminous binder poured by cans. The poured material is topped up with sand or fine chips to prevent the removal of binder under traffic. [20]

Joints: The maintenance of joints consists in examining whether the joints are properly sealed and, if not, to immediately seal them. If the preformed joint filler has rotted and deteriorated, it should be removed and substituted by a fresh compressible filling material. The sealing material is then poured. [20]

Patching of slabs: A variety of defects, such as scaling, spalling, depressions, irregularities and failures, can occur locally in a slab. In such cases, it is necessary to patch up the defective portions immediately to arrest further deterioration. Bituminous premix materials are very widely used for this purpose. When the distress is more pronounced, concrete patch-work is resorted to. Such patches are of regular geometrical shapes, without acute-angled corners. The sides are first trimmed and made vertical and fresh concrete is laid and tamped. [20]

Mud-pumping and blowing: When the subgrade becomes moist with free accumulation of water, heavy axle loads passing over the slab will eject water and mud through the joints, cracks and pavement edges. This phenomenon is known as mud-pumping and blowing. When a pavement exhibits this phenomenon, the joints and cracks should be inspected and defective ones refilled and sealed. A bituminous under-seal can be pumped underneath the slab to prevent

recurrence of the defect. This is accomplished through drilled holes in the slab. A viscous binder is preferred. This fills voids in between the slab and the subgrade. [20]

2.8 ROAD NETWORK CLASSIFICATION IN KENYA

Road infrastructure is a key driver to the development of Nations. The Kenya Vision 2030 aspires for a country firmly interconnected through a network of road, rails, ports, airports, water ways and telecommunications as well as adequately provided with energy. [2]

Road transport is the predominant mode of transport and carries about 93%of all cargo and passenger traffic in the country. [2]

According to Kenya Roads Board (2014), Kenya's road network has been established to be 160,886 km long .About 61,936km of these roads are classified while remaining 98,950km is not classified. [2]

Responsibility for the management of the road network falls under the Ministry of Roads and implemented through Kenya National Highways Authority (KeNHA),Kenya Rural Roads Authority(KeRRA),Kenya Urban Roads Authority (KURA) and Kenya Wildlife Service (KWS). [2]

2.8.1 Purpose of road classification

Road classification system serves several functions which can be said to be interrelated among them being:

Planning. The application of a road classification provides a framework for policy formulation in road administration and management. Road classification assists planners in allocating resources for maintenance and development for the road network between different groups of roads and also for setting priorities.

Design. A road classification system indicates an expected level of service for specific road classes and therefore provides guidance to design engineers in applying appropriate design standards.

Administration. Road classification also clarifies responsibilities amongst road administrations and the assignment of road sub-networks.

Usage. A well-defined and consistent road classification system influences road user expectations, behaviour and performance in traffic which improves the effectiveness with

which the road network carries traffic. Hence the road classification system should provide road users with some confidence in the level and continuity of service intended to be provided.

2.8.2 Existing road classification in Kenya

The Current Road Classification System in Kenya was developed over 30 years ago and has six road classes named from Classes A to E and a Special Purpose Road class. Each class is defined by the functional criteria related to administrative level of centres the roads connect. The system covers only 61,936km of the entire road network of 160,886km while the rest 98,950km are not classified. Each class is defined by the functional criteria related to administrative level of centres the roads connect. [2]

Table 2. 1 Summary of road classification in Kenya

CLASS	DESCRIPTION	FUNCTION
A	International Trunk Roads	Link centres of international importance and cross international boundaries or terminate at international ports or airports (e.g. Mombasa,)
B	National Trunk Roads	Link nationally important centres (e.g. Provincial headquarters)
C	Primary Roads	Link provincially important centres to each other or to higher class roads (e.g. District headquarters)
D	Secondary Roads	Link locally important centres to each other, or to more important centres or to a higher class road (e.g. divisional headquarters)
E	Minor Roads	Any link to a minor centre
SPR	G L R S T W	Government Roads Settlement Roads Rural Access Roads Sugar Roads Tea Roads Wheat Roads
U	Unclassified	All other public roads and streets

Source: Kenya Roads board website 2014

2.8.3 Justification for review of existing road classification in Kenya

Since current road classification system was developed over 30 years ago, the road network has grown rapidly and changed in character. The classification system is now perceived to be outdated and in need of a review for the following reasons among them: Rapid growth and urbanization of the population, significant expansion of the road network, Ad hoc addition of road classes to provide for special purpose roads, the existence of the large rural and urban road network (98,936km) that is currently unclassified, the successive changes in administration boundaries, affecting the validity of the original functional classification in terms of administrative centres, notably at district level, The perception of some anomalies in class assignment, whereby some higher classes of roads have significantly lower standards or lower traffic volume than some lower classes of roads and the criteria used for the classification are relatively broad and subjective.

The present system is seen to be static and unable to adjust to changing circumstances.

Rational planning and allocation of scarce funds to the road system is now perceived to require a more objective and quantifiable basis for prioritizing groups of roads than a simple functional classification system can provide.

Due to the limitations of the existing classification system, Kenya Roads Board, with funding from the Nordic Development Fund under the Northern Corridor Transport Improvement Project, commissioned a Consultant to develop a new Road Classification System in October 2006. [2]

The Consultant has reviewed the current classification system and compared with best international practices to develop a proposed new classification system. The proposed reclassification system was presented to a stakeholder's meeting in July 2007 where it was adopted. It will take effect when approved by the Minister for Roads. [2]

2.8.4. Proposed new road classification

The proposed Road Classification establishes a hierarchy of roads according to the importance of each road in the road network, the socio-economic function they serve and intend to serve. The classification enables the agency that is responsible for a planned upgrading and maintenance of the roads. Design standards and level of maintenance requirements are directly

related to the road functional class, together with other indicators such as existing and predicted traffic on the road.

The functional classification of a road is based on its proposed function and roads grouped under a particular category or class will be characterized by the level of service they provide.

The proposed classification came up with two road categories for rural and urban roads, their location in the road network and their defining characteristics

2.8.5. Expected benefits of new road classification

The expected benefits of applying the proposed road classification system are:

1. The System has formal procedures and guidelines for changing road classes or for incorporating new roads when circumstances change. It is therefore *dynamic* in nature, unlike the current system.
2. It also has a direct linkage with the volume of traffic on the road, the standard to which the road is, or will be constructed and with the level of service the road is expected to provide.
3. The System covers the entire road network in Kenya.
4. It will have a legal basis upon its approval and gazettement.
5. It shall provide a rational basis for allocation of resources for road maintenance and development between different categories of roads.
6. The road classification shall assist in the assignment of road sub-networks amongst the road administration agencies.
7. It shall provide guidance to road engineers and planners in applying appropriate geometric standards.

The system shall also influence road users' behaviour and performance in the traffic which will improve the effectiveness of the road network

2.9 INSTITUTIONAL FRAMEWORK IN KENYA

2.9.1. Road subsector reforms.

Prior to the Reforms of 2006 in the Roads Sub-Sector, the uncertainties, duplication of roles and inconsistency in the road asset management system largely contributed to poor state of roads in the country. This was mainly due to the fact that several Ministries concurrently

exercised road management responsibilities through some of their departments and agencies. Further, most road management agencies employed inefficient operational procedures under bureaucratic civil service regulations and lacked clarity in the legal, operational and structural relationships amongst themselves. [13]

The Sessional Paper No. 5 of 2006 which was approved by Parliament in October 2006 spelt out policies to be pursued by the Government in the medium term for sustained growth and provided the legal and institutional framework for the management of roads. The reforms realized the four basic building blocks necessary for effective roads management i.e. ownership, clarified responsibility, stable financing and commercialized management. In 2007, the Kenya Roads Act was enacted. The Act established three Roads Authorities with responsibility of clearly defined mandates on the management of respective sub-networks. [13]

2.9.2 Current institutional framework

Prior to the promulgation of the new Constitution, the roads sub-sector was managed as follows;

The ministry of roads: The ministry is charged with the responsibility of providing basic infrastructure facilities to the public. These include development, maintenance and rehabilitation of road network in the country. The specific responsibilities are;

- National roads development policy
- Development, standardization and maintenance of roads
- Materials testing and advice on usage
- Coordination of the activities undertaken by parastatals/authorities:
    - Kenya roads board
    - Kenya national highway authority
    - Kenya urban roads authority
    - Kenya rural roads authority
- Research and training on highways construction and building technology
- Standardization of vehicles, plant and equipment
- Registration of engineers
- Registration of road contractors

The Kenya Roads Board (KRB). It funds maintenance of all roads including approval of Roads Maintenance Levy Fund (RMLF) funded maintenance work program, and carrying out of technical and financial audits of the works. [2]

Its history dates back to 1992 when the Kenya Government together with the Road Maintenance Initiative (RMI) World Bank team hosted a Road Sector Stakeholders Seminar, to address the deteriorating condition of the road network in Kenya and the constraints to timely and proper road maintenance. The identified constraints were institutional, managerial and financial. It was resolved that a sustainable source of funding is established and the existing road management institutional set-up be reviewed. In 1993, the Road Maintenance Levy Fund (RMLF) Act was enacted, providing a sustainable source of funding for the maintenance of the road network. [2]

In 1995, with assistance of the European Commission, the Road Sector Institutional Study was commissioned. Its objective was to identify the most appropriate institutional framework within which the management of Kenya's entire road network would be most effectively undertaken. The study recommended the formation of an executive roads board, working together with identified road agencies to effectively deliver an efficient road transport system for road users in Kenya; hence the Kenya Roads Board was formed. [2]

The Kenya Roads Board (KRB) was established through an Act of Parliament, KRB ACT No. 7, in 1999 and was given presidential assent on 6th January 2000. The Act commenced on 1st July 2000 and the Board of Directors was appointed. The act specifies the following as the mandates of the board: - [2]

- Administer the funds derived from the Road Maintenance Levy Fund (RMLF) and any other funds that may accrue to it;
- Coordinate the development, rehabilitation and maintenance of the road network, with a view to achieving efficiency, cost effectiveness and safety;
- Coordinate the implementation of all policies relating to the development, rehabilitation and maintenance of the road network;

- Determine the allocation of financial resources from the RMLF or from any other source available to the Board required by road agencies for the development, rehabilitation and maintenance of the road network and

- Monitor the operations or activities undertaken by road agencies in the development, rehabilitation and maintenance of the Kenyan road network.

The KRB formation was a significant step towards reforming the road sector in Kenya. KRB's members, including both individual and corporate, come from both the public and private sectors of the economy. It has eight members from the private sector representing a large number of road user constituents and five members from the public sector. This representation provides the road users with an opportunity to effectively participate in the management of roads in Kenya while ensuring that utilization of the funds entrusted to KRB is efficiently and effectively carried out as per expectations of the stakeholders. [2]

Roads Department – provision of technical and support services to the Roads Authorities.

- **Kenya National Highways Authority (KeNHA)** is responsible for the management, development, rehabilitation and maintenance of national roads classified as classes A, B, and C Roads.
- **Kenya Rural Roads Authority (KeRRA**) is responsible for the management, development, rehabilitation and maintenance of rural roads classified as classes D, E, and unclassified rural Roads (first schedule Kenya Roads Act, 2007).
- **Kenya Urban Roads Authority (KURA)** is responsible for management, development, rehabilitation and maintenance of all public roads in cities and municipalities except where those roads are national roads.

The Kenya Wildlife Service (KWS) is responsible for roads in National Parks and National Reserves as well as access roads allocated to it by the Ministry of Roads. KWS, just like the three Roads Authorities will report to the Ministry of Roads on road development projects while Kenya Roads Board will approve its maintenance work.

2.9.3 Proposed institutional framework

After the promulgation of the new constitution, there was need to align the road sub-sector to the requirements of the constitution and was done through the ministry of roads. The purpose of the policy to articulate the government reform agenda in the roads sub-sector and to provide a basis for the enactment of legislation to strengthen the legal and regulatory framework in line

with the Constitution. The policy is also intended to provide a foundation for the establishment of governance structures for the sub-sector. [14]

The policy proposes two main categories of roads;

National Trunk Roads. These are the main roads linking Kenya to her neighbours, connecting various County headquarters and interconnecting the entire Country in an equitable and well distributed manner. The National Trunk Roads shall be gazetted by the Cabinet Secretary with approval by Parliament.

County Roads. These are all other roads within County boundaries that have not been defined as National Trunk Roads.

This policy aims at aligning the mandate and functions of the Ministry of Roads and the statutory Institutions in the roads sub-sector and implement measures to be in line with the provisions of the Constitution. Accordingly the government will align the roads sub-sector institutional framework by establishing various institutions to replace the existing ones in the sub-sector as follows:-

(i) The State Department responsible for policy and setting of standards and specifications for construction and maintenance of roads, registration of engineers, research in road transportation, mechanical function in support of road-related matters, training and certification of road transportation-relation accreditation and courses, monitoring and evaluation function and asset management. The state department will also be responsible for collection, analysis and forecasting of road traffic data for national trunk and county roads. Master planning for road sub-sector management will remain with the state department.

(ii) A body of the National Government responsible for the design, construction, operation and maintenance of National Trunk Roads, capacity building and technical assistance to counties to be known as the Kenya National Trunk Roads Authority (KENTRA). It is recommended that the structure of KENTRA shall have a headquarter office and presence in the forty seven (47) counties specified in the First Schedule to the Constitution, responsible for the national trunk roads network traversing the county.

The Kenya National Trunk Roads Authority will be a body corporate with the following functions:

a) Design, Construction and management of national trunk roads

b) Maintenance, rehabilitation of national trunk roads

c) Axle load control on national trunk roads

d) Road traffic management on the National Trunk Roads.

e) Promote participation of the private sector in the financing and management of national trunk roads.

f) Acquisition of land for roads expansion and drainage way leaves in liaison with the National Land Commission

(iii). A body responsible for sourcing and management of construction, operation and maintenance funds for the roads sub-sector except funds from the exchequer to serve both levels of government, to be known as the Roads Fund (RF). The Roads Fund will be a body corporate with the following functions:

a) Management of road maintenance funds.

b) To identify and source for alternative financing for the development and maintenance of roads.

c) Coordinating and compilation of road work plans for national and county governments and coming up with a national roads work plan.

d) Undertake technical and financial audit of road works.

(iv). County roads will be transferred to the county governments to be constructed, operated and maintained in line with the provisions of the relevant laws on devolved government and the laws governing the urban areas and cities, as well as approved standards as set by the state department responsible for roads.

2.10 SPECIAL PROGRAMMES IN THE ROAD SUB-SECTOR

2.10.1 Road 2000 strategic plan

Through the Rural Access Roads (RAR) and Minor Roads Programmes (MRP) Kenya constructed and maintained 12,000 km of rural roads in 1970's, 1980's and early 1990's. These programs were a driving force in developing labour based technology. In the late 1980's and 1990's the emphasis shifted from construction to maintenance as it was becoming evident that

Kenya was unable to maintain her roads adequately. The Roads 2000 maintenance strategy was born out of this need in the early 1990's. [14]

The Roads 2000 Strategy is a method of road development and management that ensures optimum utilization and development of locally available resources where technically; and economically feasible and in a socially responsive manner. [14]

Roads 2000 targets

The five-year National Strategic Plan for the R2000 Programme, covering the period 2005 - 2010, was developed in 2004. The Plan outlined the principles and methodologies for the programme, and, among others, set the following targets including routine and holding maintenance of 10,000 Km of Paved Roads, to increasing Routine Maintenance of un-Paved Roads from 20,000 Km to 37,000Km over the plan period, spot Improvement of 18,000 Km of unpaved roads to maintainable standard, creation of 150,000 temporary jobs (35,000 fulltime) annually, to train 1,250 active labour based contractors and to improved quality and cost effectiveness of road works. [14]

There are several Roads 2000 programmes that were implemented in all parts of the country except in the North Eastern province. Significant achievements were made in all the programmes particularly in employment creation, training and creating economic and social opportunities for vulnerable groups such as women and the youth. [14]

Roads 2000 challenges

Despite the achievements made, the programme experienced some challenges as below:

a) In spite of its apparent benefits, the R2000 concept is not yet fully mainstreamed in regular programmes of most implementing bodies and remains to be donor driven.
b) The programme is not yet accompanied by a long-term network development plan.
c) Low level of awareness and buy-in among engineers and policy makers about R2000.
d) Lack of technical and managerial capacity at regional levels.
e) Crosscutting issues which are becoming increasingly important in the road sub-sector are not yet fully incorporated in the training programme.
f) Some target outputs of R2000 projects not yet fully anchored to the performance contract of implementing agencies

A committee constituted by the then Minister to review the programme concluded that one; despite some challenges, the Roads 2000 programme has achieved most of the targets set in the 2005-2010 Strategy. Two; R2000 programme is one of the sectoral interventions that has covered wider thematic areas, created significant employment and injected most needed income into the rural economy. [14]

Lastly The Roads 2000 Strategy by and large has been accepted as a main instrument for: Delivering road improvement and maintenance works and also for providing employment-based social protection for the rural and urban poor. [14]

Therefore it was of paramount importance to upscale the implementation of R2000 programme nationwide in order to expand the benefits realized so far and contribute more towards the national goal of poverty reduction and enhanced socioeconomic growth of Kenya. This led to the second strategic plan 2013-2017. [14]

Roads 2000 Strategic plan 2013-2017

The Roads 2000 Strategy contributes to achieving the national development goal aimed at by the Kenya Vision 2030. Consequently the Strategy Vision which is to attain and sustain excellence in road development and management that contributes to the National Development Priorities of Kenya. [14]

The national targets to be achieved over the plan period are; Routine Maintenance (Paved) – 2,536km annually, Routine Maintenance (Unpaved) – 31,599km annually, Periodic Maintenance(Paved)–1,538km,Periodic Maintenance (Unpaved)–10,683kmRehabilitation/Spot Improvement (Paved) – 472km, Rehabilitation Spot Improvement (Unpaved) – 890km,Upgrading (Paved) –569kmUpgrading (Unpaved) – 40km,New Construction/Reconstruction (Paved) – 194km,New Construction (Unpaved) – 513km and creation of employment for 23 Million Person-days (104,274jobs) annually over the plan period with a minimum of 33.3% being women and 2% being Persons Living With Disabilities

The committee set the following financial targets to various agencies for them to achieve said targets over the next five years.

Table 2.2 showing targeted budget and targeted physical length

AGENCY	BUDGET (Kshs. mill)	PHYSICAL LENGTH (KM)
KeNHA	38,699	22,995
KeRRA	595,249	160,225
KURA	11,132	840

Source: Roads 2000 strategic plan 2013-2017 (2013)

2.10.2 Road inventory and condition survey (RICS)

In 2001, the Ministry of Roads, with financing from World Bank, engaged a Consultant to undertake a Road inventory and Condition Survey (RICS) for the Classified Roads using Geographical Positioning Systems. The RICS study led to the establishment of a database for classified roads in a Geographical Information System. Unfortunately, the extent of the unclassified rural and urban roads remained unknown making it difficult for effective maintenance and development planning. [2]

In view of the above and in order to establish the extent of the existing road network and its condition, Kenya Roads Board, with funding from the Nordic Development Fund under the Northern Corridor Transport Improvement Project, in 2006, commissioned a Consultant to undertake a road inventory and condition survey for the hitherto unclassified road network. [2]

The Consultant was also required to combine the Road Inventory and Condition data for the classified roads undertaken in the previous study by Ministry of Roads so as to have the entire road network inventoried and its current condition known. [2]

The data collected by the consultant lead to establishment of Geographical Information Systems (GIS) database. This provides comprehensive road inventory and condition data which is essential for planning and implementation of maintenance and development programmes by Road Authorities. [2]

The Consultant also prepared new road maps for the national roads, districts and urban centres as well as thematic maps for surface type, surface condition and traffic.

There has been some improvement in the road network condition for the classified roads which is currently estimated at 17% good, 51% fair and 31% in poor condition. However, a majority of the unclassified roads are in unmaintainable condition with only 5% good, 22% fair while 72% is in poor condition. Hence a large portion of the network is in either poor or failed condition and requires urgent rehabilitation to restore it to a maintainable condition. The government therefore, urgently needs additional funding to restore the network to a maintainable condition. [2]

Table2.2: Summary road conditions

	Good	**Fair**	**Poor**	**Grand Total**
Classified roads	10,651	31,847	19,438	61,936
Unclassified roads	5,440	22,165	71,345	98,950
Grand Total	**16,090**	**54,012**	**90,784**	**160,886**

Source: KRB website 2015

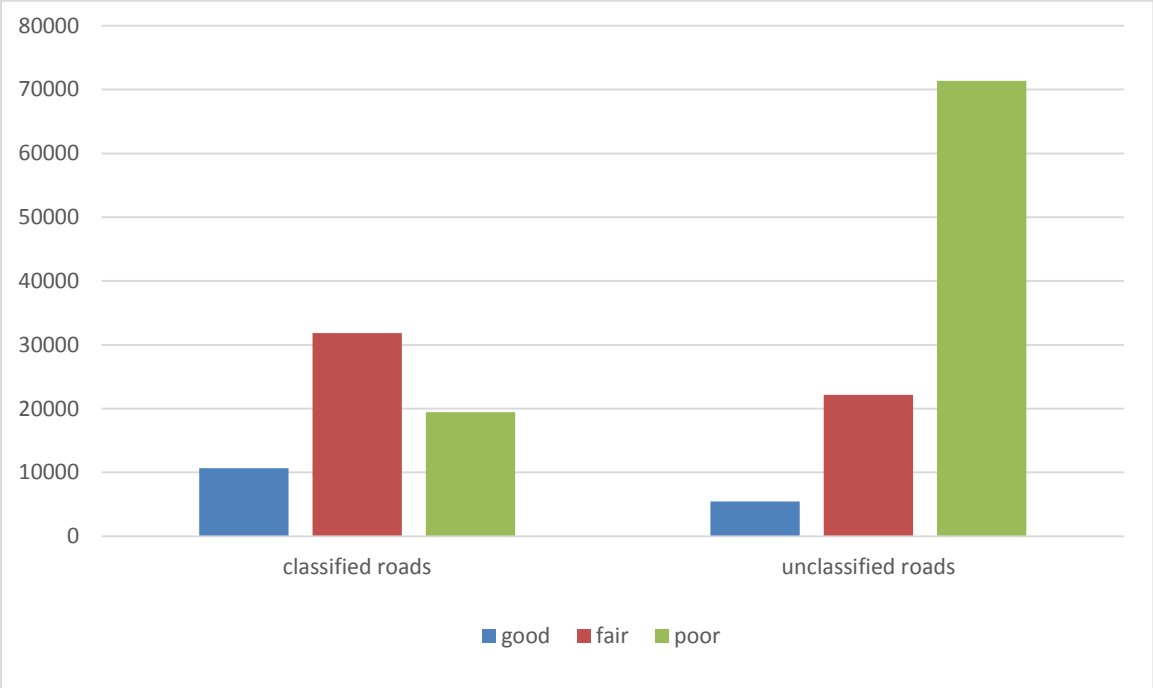


Figure 2.1: Road conditions in Kenya

2.10.3 Cost evaluation manual.

In 2011, the ministry of roads in association with Japan International Cooperation Agency (JICA) developed a manual on cost evaluation. It had been found necessary to standardize the

cost estimation of road maintenance countrywide, this was to achieve value for money in our roads construction and maintenance. [14]

The manual provides roads Authorities a scientific index on the approximate price of maintenance works for the tendered works by factoring in input components comprising labour, salaries and wages, materials, plant and equipment. This was derived from a survey that evaluated the condition of the segment of the road in need of preventive maintenance to protect capital investments. It gives instructions for estimating the cost of road maintenance works, by considering all the above inputs. This is to provide a standardized procedure of pricing road activities in Kenya, to ensure uniformity in public and private procurement practice. [14]

The manual is applied in the preparation of Engineer's Estimate for tender documentation by procurement entities and provides a benchmark for evaluation of bidding prices. Also it is used for the formulation of annual work plans by the roads authorities and as an auditing tool for ongoing road works. Lastly it can also be used as a reference for bidders to prepare their bidding documents while considering their unique cost settings. [14]

2.11 MAINTENANCE FUNDING

Sources of funding for road maintenance included; fuel levy, transit tolls, CESS, among others. Maintenance of roads remained almost wholly financed from the Road Maintenance Levy Fund (RMLF). Of the listed sources of funding for road maintenance, fuel levy and transit toll accounted for the vast share, with the former accounting for approximately 96% and the latter accounting for the remainder. [2]

The RMLF created by an Act of parliament in 1993, is the only sustainable source of funding for the road maintenance Originally set at KShs.1.50 per litre for petrol and KShs.1.00 per litre for diesel, the rate for this levy has since been increased several times, the latest being in Financial Year (FY) 2006/07 from about KShs.5.80 to KShs.9.00 per litre for both petrol and diesel. [15]

Table 2.3 showing road maintenance levy fund rates progression

Financial Year	Petrol (KShs/litre)	Diesel(KShs/litre)
June 1993	1.5	1.0
June 1994	1.5	1.0
June 1995	2.0	1.5
June 1996/1997	2.7	2.2
June 1998	4.8	4.8
June 1999 to June 2006	5.8	5.8
June 2006 to date	9.0	9.0

Source:

Toll roads are an ancient concept whose history dates back in in the Holy Roman Empire. Toll means the charges prescribed for a use of a certain road. In Kenya currently, only heavy goods vehicle are tolled. By law, heavy goods vehicle is defined as commercial vehicle whose tare weight exceeds seven thousand kilograms; and includes semi-trailers and draw bar trailers irrespective of their nominal weight. [21]

CESS is a form of tax which is provided in the agricultural act. It applies to all crop and livestock produce marketed within local authorities and on transit by road within the country. The rate at which and how is administered is arbitrary and changes from time to time at the discretion of the respective local authority. [22]

According to KRB 2015, it is estimated that the backlog maintenance for the paved network requires approximately KShs. 400 billion, Kshs. 70 billion for on-going and committed roads and KShs. 131billion for the national, rural roads and part of the paved urban roads in first five years to address backlog. [2]

Also the balance of backlog on the paved urban roads amounting to KShs. 27 billion has been deferred to after 2014 due to lack of funds. The review of the RSIP is due this financial year (2014-2015). In addition, the estimated annual maintenance costs is Kshs 40billion per year (currently at about KShs. 50 billion per year) and an increase of fuel levy at least by Kshs 3 is recommended to bridge the maintenance gap. All cost figures are in year 2008 prices. [2]

2.11.1. Funding criteria

Kenya Roads Board manages the roads fund which is required by road agencies for maintenance, rehabilitation and development of road network. KRB ensures that the allocation

of funds is pegged to specific categories of roads. This disbursement criterion ensures that not less than;

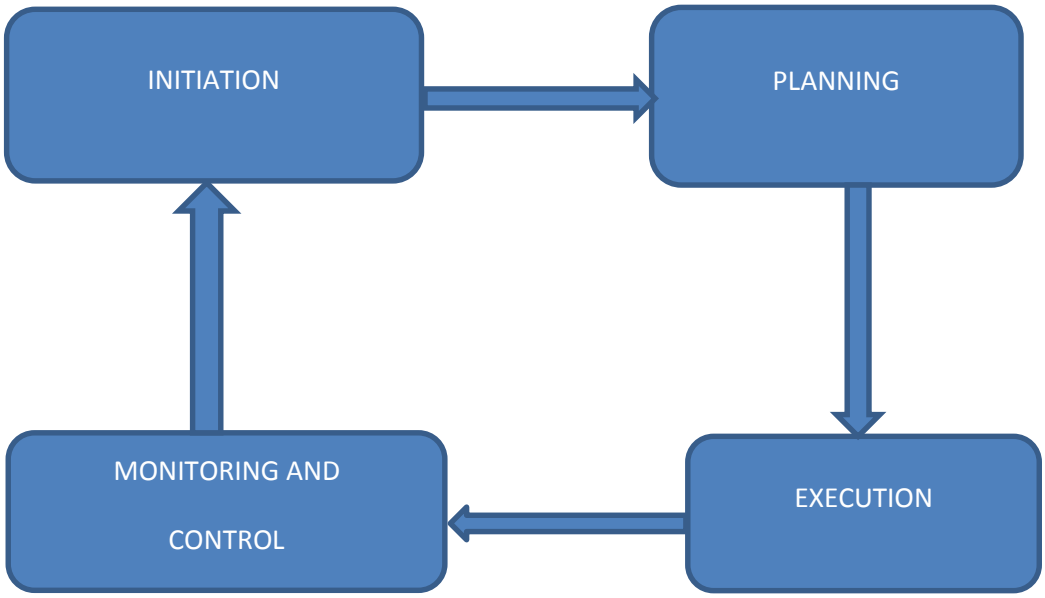
- Twenty two percent (22%) shall be deposited into special bank account to be called constituency roads and account to be maintained by every constituency of the monies from the fund is allocated equally to all constituencies in the country to be administered by the Rural Roads Authority
- Ten percent (10%) of the monies from the fund is allocated for the maintenance or development of link roads between constituencies and to serve as government counterpart funds in funding works on rural roads, to be administered by the Kenya Rural Roads Authority and the said per centum shall be equally distributed to the constituency where Kenya Rural Roads Authority has the mandate.
- Forty percent (40%) of the monies from the fund is allocated in respect to the national roads to be administered by the Kenya National Highways Authority.
- Fifteen percent (15%) of the monies from the fund is allocated in respect of the Urban Roads Authority.
- One percent (1%)of the fund is allocated in respect to roads in the national parks and reserves to be administered by the Kenya wildlife Service: and
- A maximum of two percent (2%)of the monies from the fund is allocated in respect of recurrent expenditure of the board

The remainder of the monies from the fund (10%) described shall be allocated annually by the board with the approval of the minister to road investment programme derived from the five year roads investment programme approved by the minister responsible for roads and minister of finance.

2.12 ROAD MAINTENANCE CYCLE IN KENYA

The road maintenance cycle practicing by agencies involved can be simply summarized as below.

- Initiation – get information about the asset (road) from the database, annual data collection, feedback and also the complaint system;
- Planning – plan the budgeting using the prioritizing systems
- Execution – use the work program to implementation
- Monitoring/control – the agencies control the maintenance based on the monthly progress, quarterly financial meeting and audit;



2.12.1 Annual Road Work Program (ARWP)

There is a procedure used and its purpose is to ensure there is consistency, transparency: accountability and timelines in the preparation of the annual maintenance work plans for roads.

The process is initiated by the General Manager (GM)-Maintenance communicating to the regional manager (RM) around the month of November.

The RM informs the senior engineer to prepare annual road maintenance work plan in consultation with regional roads superintendent and the surveyor. The preparation involves the use of RMMS in which following information is vital. One; the length, road number and surface type of each road or road section. Two; the budget ceiling for the region and allocation for the roads for both current and next financial year. Third; annual road inventory and condition survey. And lastly the On-going works

The senior engineer then present the report to the RM for concurrence and allocation of funds guided by the budget, ARICS and spread of works across the region and the financial year.

Upon concurrence, they submit the ARWP for approval. This is done at levels from the general manager maintenance, to the director general of the agency and to the board of directors of the agency.

It should however be noted that for KeRRA, the constituency road committee (CRC) is in-charge of prioritizing the roads to be maintained. The members comprises of members of the public appointed by the member of parliament of that particular constituency and the RM.

2.12.2 Implementation and monitoring

A road agency entrusts a private firm with maintenance and operation of a road or part of a network in form of a contract.

A contract is defined as: "an agreement made between two or more parties which is enforceable by law to provide something in return for something else from a second party". When a contract is properly set-up, it is legally binding upon. The two parties are expected to perform the various obligations they have undertaken, as expressed in a mutually agreed set of contract documents. A contract therefore, is necessary to protect both client and contractor. [17]

When a road agency entrusts a private firm with maintenance and operation of a road or part of a network, the contract can take three main forms:

(1) Admeasurement contracts: In this type of contracting, items of work are specified in Bills of Quantities or Schedule of Rates. The contractor then specifies rates against each item. The rates include risk contingency. Payment is paid monthly for all work completed during the month. The contract offers a facility for the client to introduce changes in the work defined in the tender documents. The contractor can claim additional payment for any changes in the work content of the contract. Claims resolution is very difficult because the client has no knowledge of actual cost or hidden contingency. Tender price is usually increased by variations and claims. Two forms of admeasurement contract are usually used: bill of quantities and schedule of rates. [17]

Bill of Quantities Contract: Tenderers enter rates against each item of the estimated quantities of work. The quantities are re-measured during the course of the contract, valued at the tendered rates and the contract price adjusted accordingly. [17]

Schedule of Rates Contract: It contains inaccurate quantities of work, possibly with upper and lower probable limits. Therefore, it is common for separate rates to be quoted for labour, plant, and materials. The contract price is derived by measuring the man-hours, plant-hours and the quantities of materials actually consumed, and then pricing them at the tendered price. This contract is best suitable for repetitive works. [17]

The admeasurement contract is well understood and widely used. It can be used when little or no changes are expected, level of risk is low and quantifiable, and when design and construction need to be overlapped

The main problem of such an arrangement lies in the fact that the contractor has the wrong incentive, which is to carry out the maximum amount of works, in order to maximize its turnover and profits. It has often been observed that even if much work is carried out and much money is spent, the overall service quality for the Road User is below expected standards. [17]

(2) Performance-based maintenance contracts addresses the issue of inadequate incentives by fixing a monthly lump sum fee per km to be paid to the Contractor. It is important to understand that the contractors are not paid directly for physical works (which they will certainly have to carry out), but for the service of ensuring certain service quality criteria on the roads under contract. The remuneration paid to the contractor will implicitly cover all physical and non-physical services provided by it, except for emergency works. [17]

In order to be entitled to the monthly payment, the contractor must ensure that the roads under contract comply with the service quality levels which have been specified in the contract. [14]

It is possible that during some months the contractor will have to carry out a rather large amount of physical works in order to comply with the required service levels and very little work during other months. Yet his monthly payment remains the same as long as the required service levels are complied with. [17]

One fundamental feature of the performance-based contract is that the contractor is entirely free to decide and carry out all actions he believes are necessary in order to comply with the service quality levels stated in the contract. [17]

The service quality levels are defined from a Road User's perspective and may include factors such as average travel speeds, riding comfort, safety features, etc. If the service quality is not achieved in any given month, the payment for that month may be reduced or even suspended (Performance requirements in Operation & Maintenance contracts). [17]

Under the performance-based contract, the contractor has a strong financial incentive to be efficient: In order to maximize profits, it must reduce his activity to the smallest possible volume of intelligently designed interventions, which nevertheless ensure that a pre-defined outcome (service level) is achieved and maintained over time. [17]

(3) Lump-sum contract: A single tendered price is given for the completion of specified work to the satisfaction of the client by a certain date. Payment may be staged at intervals on the completion. The tendered price may include high level of financing and high risk contingency. Where considerable risk has been places with the contractor, this contract may lead to cost cutting, trivia claims, or bankruptcy. Contract final price is known at tender. A lump-sum contract would seem to prevent risks for the client where in fact it just changes them. An important risk to the client is that of not receiving competitive bids from desirable contractors who may avoid a high-risk lump-sum contract. [17]

2.13 CASE STUDIES ON ROAD MAINTENANCE.

2.13.1 SCOTLAND

The condition of Scotland's roads was worsening and only 63 per cent are now in acceptable condition. The cost of removing all Scotland's road defects is estimated to be £2.25 billion. Transport Scotland estimates its road maintenance backlog at £713 million (£480 million more than in 2004) while councils estimate it would cost £1.54 billion to fix all carriageway defects (£640 million more than in 2004). All councils and Transport Scotland have a road maintenance backlog. [18]

Scotland's road network consists of almost 56,000 kilometres of road. Transport Scotland is responsible for 3,400 kilometres of motorways and trunk roads. Councils are responsible for 26,000 kilometres of classified roads and 26,400 kilometres of unclassified roads. Motorways and trunk roads make up only six per cent of the road length but carry over a third of the traffic. [18]

Road maintenance covers all work on roads other than major new-build or reconstruction work. It includes structural, environmental, weather and winter maintenance, lighting, safety maintenance, emergency patching and routine repairs. [18]

Two separate surveys conducted recently indicate that user satisfaction with the condition and maintenance of Scotland's roads has decreased over the last ten years. In 2008, a survey of 17,500 Automobile Association members found that 55 per cent of members in Scotland believed that road condition was worse than a decade ago. In 2010, a similar survey by the RAC Foundation found that 52 per cent of users were dissatisfied with road maintenance in their area. [18]

Poor road condition can result in motorists incurring expensive repair bills, and councils face claims from road users who have had their vehicles damaged by potholes and similar defects. In 2010, a survey estimated that over a third of Scottish motorists have suffered car damage because of potholes. The average cost of repairing the damage to their vehicles is thought to be £133 per driver. Another survey of 3,000 drivers estimated that an average of £220 per motorist was being spent each year on pothole-related car repairs such as suspension problems, burst tyres, chipped windscreens and paintwork damage. [18]

Councils and Transport Scotland spent £654 million on road maintenance in 2009/10. Taking inflation into account this was an increase of £32 million (five per cent) on expenditure in 2004/05. Scots considers present levels of spending are insufficient to maintain Scotland's roads in their current condition. [18]

In our 2004 maintaining Scotland's roads report, the recommendation on how the councils had to improve their management of road maintenance was by: developing road maintenance strategies, collecting better inventory information, having up-to-date information on the condition of assets and developing a framework of performance indicators. [18]

2.13.2 NAMIBIA

The Namibia road sector underwent a fundamental change on April 2000 as three new road sector organizations, the Road Fund Administration (RFA), the Roads Authority (RA) and the Roads Contractor Company (RCC) were created and about 2500 persons who were previously employed I the Namibian civil service, were transferred to the roads sector. [19]

Some of the notable aspects of the reforms are included the road sector becoming fully self-financed by way of road user charges. The self-financing system, which comprises of the road user charges and the road fund is administered by the RFA, an autonomous state agency under the ministry of finance. Additionally, the national road network is managed by the RA, a state agency with considerable autonomy under the Ministry of Works, Transport and Communication.

All roads are expected to competitive bidding process, but during a three-year period the state-owned RCC will have exclusive rights to do the maintenance work on the national road network

CHAPTER 3

3.0 DATA COLLECTION

3.1 Introduction.

This chapter highlights the chronological order of research methodology, discusses on how the research methodology was conducted in order to achieve the objectives of this research. From there, an analysis was conducted to study the data obtained from agencies involved and finally, based on the results obtained, a conclusion is derived.

The data collected covered entire Nairobi City County. It included collection of data information from various agencies associated with road maintenance and interviews various persons.

3.2 Data collection methodology

Maintenance funding budget for previous years was obtained from the Kenya Roads Board. The data included disbursement criteria of the funds to be given to various road agencies.

Sample roads were selected for better analysis of the information obtained from the agencies. One road or road section per agency was selected. The selection was at the discretion of the engineer as had to be and on-going at the time of this study.

Estimated maintenance budget and actual maintenance costs were compared in Nairobi County. The information was helpful to evaluate the efficiency of road maintenance.

Discussions were also conducted with the Engineer. The interviews helped to clarify how the road work plans are prepared, who's in charge of maintenance operations and methods used for maintenance.

3.3 Data collected

Data collected was divided into two distinctive categories. Primary data which was any data obtained from the agencies or observed from first-hand experiences. Second was secondary data, which was any data published or collected by other parties other than the agencies.

3.3.1 Primary data

Maintenance activities of the sample roads in Nairobi City County: These included the road work plans for various road sections.

Disbursement of maintenance funding: It included information on the estimated cost for each road section. The estimates help in making the budget for the financial year.

Photographs were used to carry out visual inspection of the study roads. They included photographs of problems identified.

Discussions with the Engineer was used to clarify the data obtained from the agency and any other information which needed clarity.

3.3.2 Secondary data

Secondary data can be obtained through literature, references such as books, journals, reports, internet surfing.

CHAPTER 4

4.0 DATA ANALYSIS AND DISCUSSION

All data was scrutinized carefully to eliminate the irrelevant elements. Relevant and useful data will be sorted and organized in such a way as to simplify data analysis

At the time of this study, the maintenance works was carried out by both the National and County Governments. For the national government, its carried out by the Ministry of Roads and implemented through Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA), Kenya Urban Roads Authority (KURA) and Kenya Wildlife Service (KWS)

For the purpose of this study the Kenya Wildlife service (KWS) was not involved

4.1 FINANCIAL TREND

4.1.1 Kenya Roads Board (KRB).

It funds maintenance of all roads including approval of Roads Maintenance Levy Fund (RMLF) funded maintenance work program, and carrying out of technical and financial audits of the works.

Since its inception it has been funding the maintenance works in the county through the provincial administration. However, with the enactment of roads act, they fund the maintenance through the national government implementing agencies.

The road agencies that is Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA) and Kenya Urban Roads Authority (KURA) became fully functional in the financial year 2011-2012.

Its funds are from RMLF, Transit Tolls and agricultural cess.

Table 4.1 KRB collections

FINANCIAL YEAR	**AMOUNTS**
2010-2011	23,775,670,912
2011-2012	24,402,271,200
2012-2013	24,814,043,168
2013-2014	25,174,472,500

Figure 4.1: trends of KRB collections

The funds collected by the board have been on the increase. These can be attributed to an increase in the amounts collected on the RMLF. This implies that people are spending more to on fuel every year. This can be termed as good as the more the money KRB can raise, the more the resources will be available for maintenance.

The road agencies that is Kenya National Highways Authority (KeNHA), Kenya Rural Roads Authority (KeRRA) and Kenya Urban Roads Authority (KURA) became fully functional in the financial year 2011-2012.

4.1.2 Kenya Rural Roads Authority (KeRRA)

The criterion used for allocating the money allocated to Kenya Rural Roads Authority (KeRRA) by KRB is by use of constituencies. Each constituency receives equal amount of the 10% and 22% RMLF.

10% RMLF is used for the maintenance or development of link roads between constituencies and to serve as government counterpart funds in funding works on rural roads while the 22% RMLF is deposited into special bank account to be called constituency roads and account to be maintained by every constituency.

The preparation ARWP and prioritization of funds is done by the constituency roads committee (CRC) in consultation with the regional manager.

Table 4.2 KeRRA allocation per constituency

YEAR	10% RMLF (millions)	22% RMLF (millions)
2011-2012	9.3	20.4
2012-2013	9.4	20.8
2013-2014	7.1	15.7
2014-2015	7.19	15.9

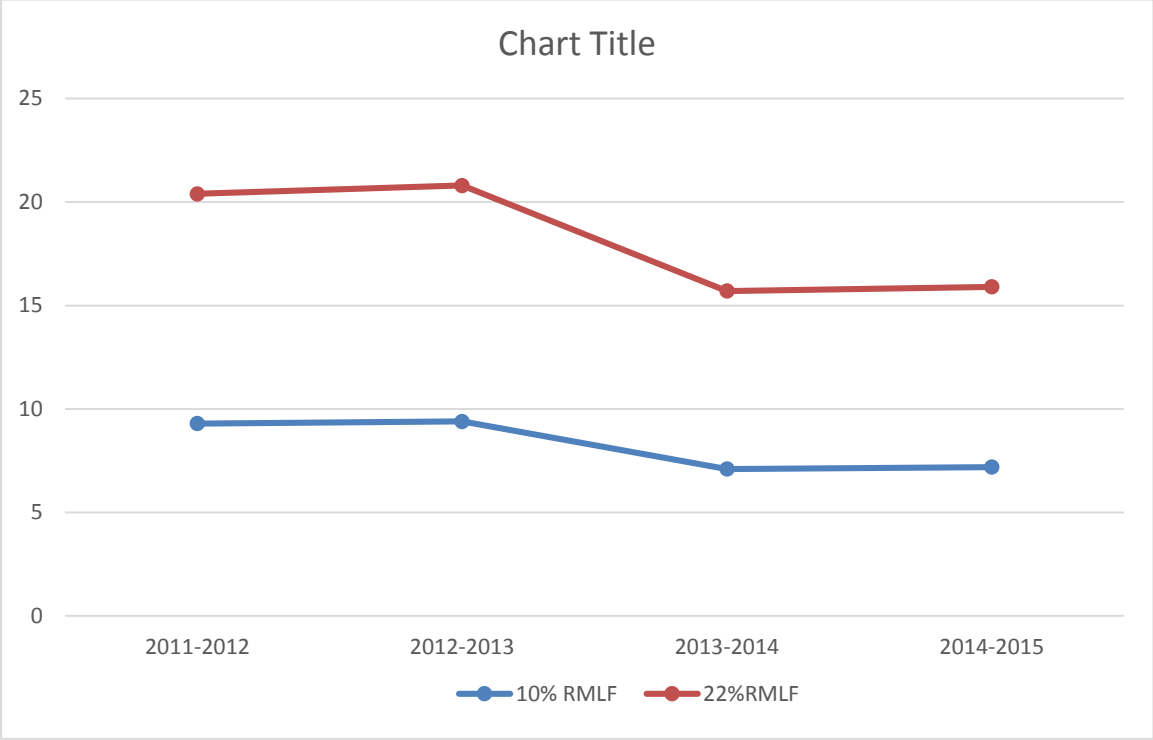


Figure 4.2: KeRRA financial trends

There was a sudden drop of the amount allocated to constituencies in the year 2013-2014 from what was being disbursed the previous year. It should be noted before the end of financial year 2010-2011, Kenya inaugurated a new constitution. This meant that when the new elections were held in the year march 2013, there was an increase of constituencies from eight to seventeen.

4.1.3 Kenya Urban Roads Authority (KURA)

The agency is in-charge of 2000km of paved roads in the county. Out of those, 450km only are in their annual work program permanently. This represents 0.23% of the total road network.

For proper administration, Nairobi County is divided into four regions namely;

NCC DIV 1-CENTRAL,

NCC-DIV 2 - EMBAKASI

NCC DIV 3 –NORTHERN

NCC-DIV4 – DAGORETTI

Table 4.3: KURA approved allocation

FINANCIAL YEAR	ALLOCATION
2011-2012	963,890,385.74
2012-2013	1,293,499,600.00
2013-2014	1,416,339,629.70
2014-2015	1,288,326,876.37

Figure 4.3: KURA financial trend

4.1.4 Kenya National Highways Authority (KeNHA)

The mandate of the agency regional office extends beyond the Nairobi City County to the neighbouring counties. This is because the class A, B and C of roads as mandated by the roads act extends beyond the borders of the Nairobi County.

Table 4.4 KeNHA approved allocation

FINANCIAL YEAR	ALLOCATION
2011-2012	620,677,213.1
2012-2013	632,240,000
2013-2014	662,745,580
2014-2015	693,365,000

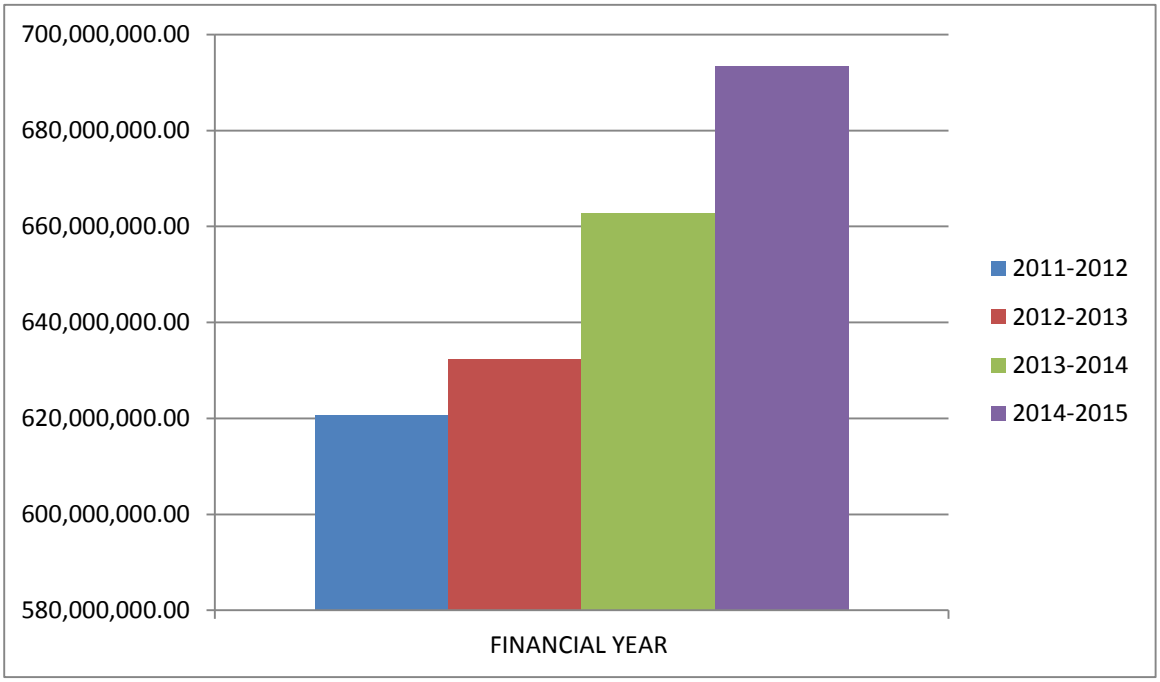


Figure 4.4 KeNHA financial trends

The funding has been relatively increased at a quite a slow late. These can be attributed to the funding available for the agency from KRB increasing at almost similar rate. This means that the works the agency can undertake remain relatively the same over the period of study.

4.1.5 Nairobi County Government

There is no clear definition on the roads the county should maintain; they maintain any road not in the ARWP of the agencies. The county does the maintenance works through its own department of highways. It has its own plant along Nanyuki road. This is unlike the rest of involved agencies who contracts' for the works.

Table 4.5 Nairobi County Government allocation

YEAR	ALLOCATION
2011-2012	208,556,925
2012-2013	251,545,231
2013-2014	552,154,026

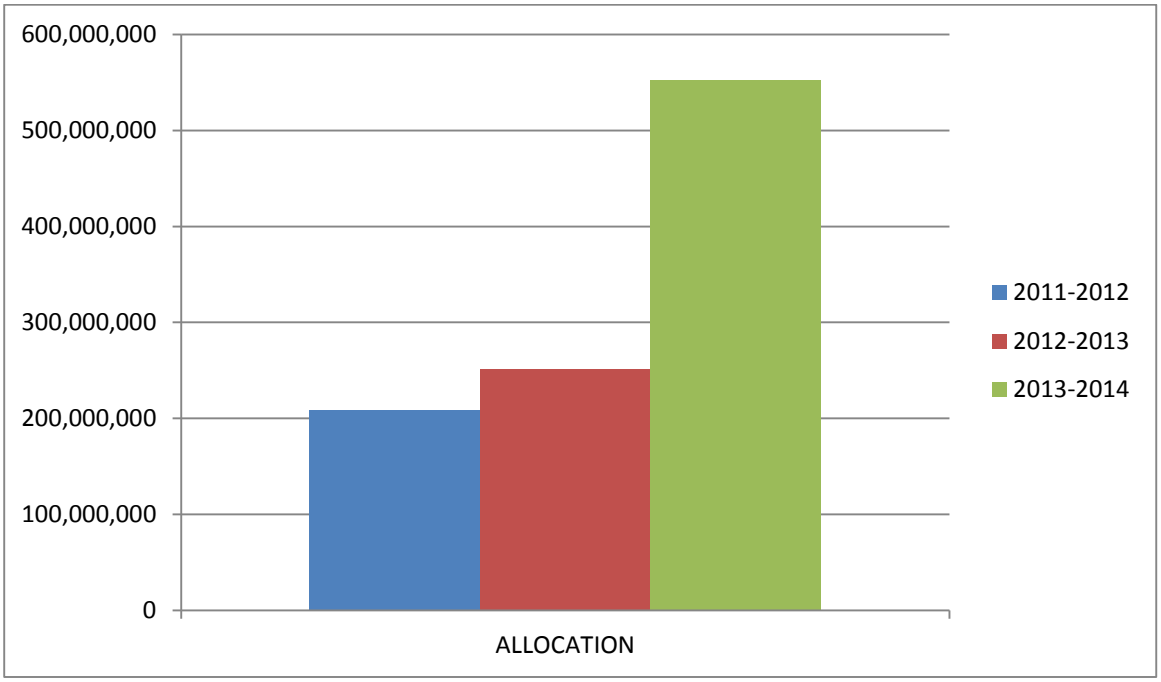


Figure 4.5: Nairobi County Government financial trends

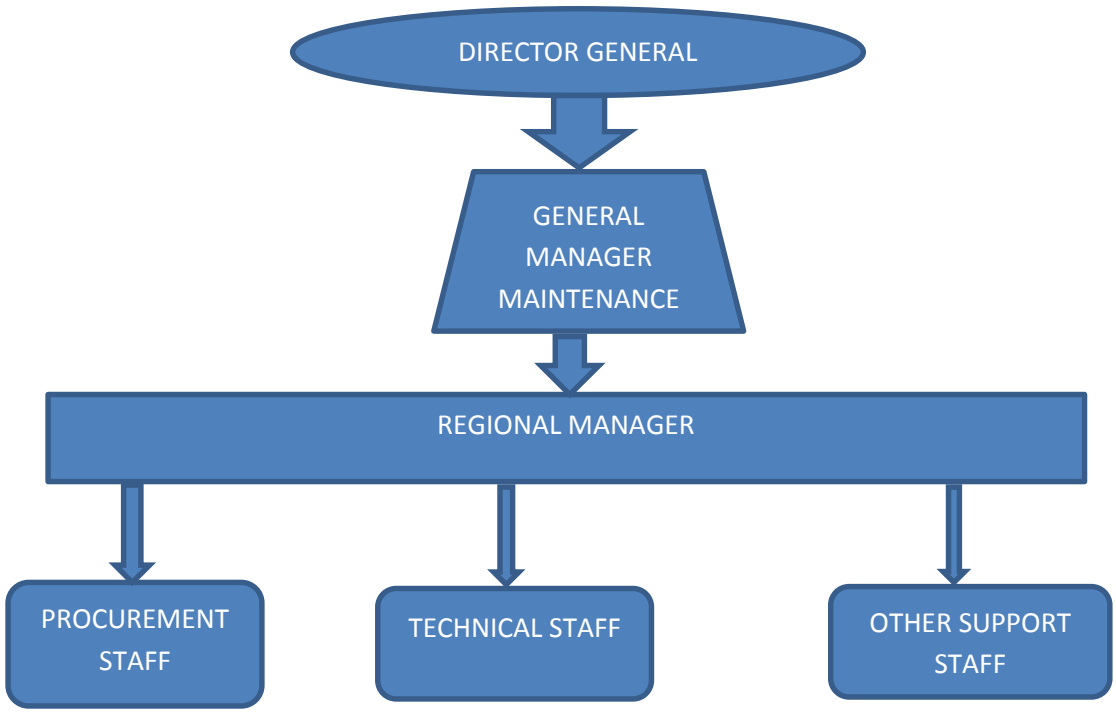
The sudden increase in amount spent on road maintenance can be attributed to the coming into being of the county government. The governor pledged to commit more resources on roads and from the records more resources have been allocated.

4.2 INSTITUTIONAL CHALLENGES

From the discussions with the engineers involved in the agencies involved, it was clear they experienced challenges in the implementation of mandate

4.2.1 Institutional capacity

Every agency have staff and their hierarchy is as below;



The Director General is in-charge of all the agency at the national level. He is responsible for all the activities undertaken by the agency including maintenance, new constructions among others. Maintenance is a department by its own and it is manned by a General Manager. The country is subdivided into regions and responsibility is further delegated to the Regional Managers.

The regional managers are required to have an office and staff in three main field; procurement, technical and other support staff. The staff are employed by the needs of the agencies this according to the regional managers.

It was clear that KeRRA Nairobi region has only one engineer and no any other technical staff member. With an average of 3 roads per constituency which are 17 in number, this is quite overwhelming for the engineer to monitor and supervise. There is clear need to hire qualified professional to do the monitoring

In one of the sample road selected, the BH road, which is under the jurisdiction of KeRRA. The supervisor was not trained as engineer nor does he not have any technical training. From discussion with him, it was established he had learnt the "trade" through apprentice. This is very risky as it does not make him competent enough to handle such.

For the other agencies, the staffs are stretched to capacity and hence there is inadequacy and if the all roads are to be covered effectively more qualified staff must be hired.

4.2.2 Insufficient funds

There is common consensus that the more resources you allocate to maintenance, the more maintenance works can be carried out and hence the better road network conditions. Nairobi county paved road-length according to the county highway department is about 2000km. There has been significant increase on the budgetary allocation over the years as shown below.

YEAR	**Total Length (KM)**	**% OF ROAD COVERED**	**Amounts spent on road maintenance (Ksh)**
2011-2012	938.19	**0.469**	1,410,371,858.50
2012-2013	986.04	**0.493**	1,736,992,233.00
2013-2014	1338,24	**0.699**	2,356,259,000.50

With increased allocation means the agencies can be able to cover more road-length. However as the statics shows there are a large proportion of roads still miss out on routine maintenance leading to faster deterioration. Lack of routine maintenance to those roads means that, the road surface condition will have deteriorated significantly at the end of the design life. This in turn means more money will have to be spent to restore it to near design condition.

4.2.3 Work preparation and planning

The preparation of the work programmes was done by the individual agencies. These are according to the procedure set by the agencies. They adhere to the budget ceiling previously set by the KRB before the work plans have been prepared. The preparation involves the use of road maintenance management system (RMMS).

The Kenya Urban Roads Authority (KURA), Kenya Rural Roads Authority (KeRRA) and the Kenya National Highways Authority (KeNHA) allocate money for routine maintenance, periodic maintenance and spot improvement. The allocation depends on the surface condition needs and the budget ceiling available.

Once individual agency have prepared the work-plans, it submit it to the Kenya Roads Board for approval. KRB may revise the work-plans depending on the amount expected to be collected.

Table 4.7: Nairobi County proposed and approved budgets

YEAR	KeNHA		KURA		KERA	
	PROPOSED (Ksh.)	APPROVED (Ksh.)	PROPOSED (Ksh.)	APPROVED (Ksh.)	PROPOSED (Ksh.)	APPROVED (Ksh.)
2011-2012	668,945,197	**620,677,213**	1,603,211,367	**1,416,339,629**	244,508,909	**237,924,567**
2012-2013	696,234,000	**632,240,000**	1,457,567,390	**1,293,499,600**	254,304,230	**241,947,741**
2013-2014	728,456,820	**662,745,580**	1,156,007,984	**963,890,385**	403,093,815	**387,765,344**

The data obtained showed that between years 2011 to year 2014, the Kenya Roads Board have been revising the work-plans downwards. These means that the agencies have not been able to maintain all the roads as planned. From the discussion with the RM's, the KRB revise the budgets by removing some of the planned activities of the work-plans. These means some activities will not be carried out hence maintenance not fully carried out.

However, this cannot be said for the county government. There is no clear workplan. All is left at the digression of the engineer in-charge to determine which road or road section is to get maintenance.

4.2.4 Works Costing

The maintenance needs of a road are quantified. The costing is done according to the set rates by the agencies. The costing follows the guidelines of the cost evaluation manual. This is to have uniformity in the preparation of the bill of quantities.

It should however be noted that, in the award of contracts, the lowest bidder wins. This is regardless of the fact that he/she quoted a rate lower than the set standards as long as he/she demonstrate they can undertake the works.

To carry out standard routine maintenance on 1km of paved road, it was observed that it would cost 3million shillings. With the Nairobi City County having 2000km of paved road, it can therefore be said that the county needs 6 billion shillings to do its maintenance works and to keep her roads in a good condition.

Table 4.8: unit costing to maintain a standard one kilometre of paved road

DESCRIPTION	**RATES (In Kshs.)**	**QUANTITY (Average per kilometre)**	**TOTAL COST (In KShs.)**
Bush clearing	6	2000m^2	12,000
Culvert cleaning	465	1000m	465,000
Pothole patching with premix	21,000	80	1,680,000
Traffic signs replacement	15,751	5	78,755
Manual road marking	166	1000	166,000
Ditch cleaning	368	2000	736,000
TOTAL AMOUNT			**3,137,755**

These amount remains an elusive dream when compared to the most recent allocation of 2,356,259,000 representing only 0.40% in 2013-2014 financial year.

4.3 MAINTENANCE WORKS

A significant percentage of unpaved roads in the county have received routine maintenance under the years under review; with occasional periodic maintenance comprising mainly of re-gravelling operations.

The same can be said about the paved roads. A significant number have received routine maintenance and spot improvement; with periodic maintenance to the extent the budget have allowed.

Routine maintenance operations carried out ranged from repair of drainage features e.g. culvert inlets and outlet, repair of side drains: carriageway operations examples being filling of potholes and repair of failed areas; removal of obstacles and bush clearing.

To better understand the trends, few sample roads were taken as below

4.3.1 BH Road

It is unclassified road and is located in mathare constituency. The road was selected as was a unique case whereby initially was just a 1m wide pathway as it had been encroached by the public. It provides access and open up the densely populated informal settlement.

Figure 4.5: section of BH road drain and already completed road section

It length is 0.9km. The contract sum was Ksh.14,359,597 which were well less than the estimated budget (Ksh.15,408,512). It was planned that periodic maintenance was to be carried out by upgrading the road and to pave with concrete blocks which were said by the engineer to be more effective as they require less maintenance as compared to bituminous surface.

4.3.2 Argwing kodhek Road

The works are located within Nairobi North Sub-Region of Nairobi Region and implemented by KURA. Arwings Kodhek Road start at Ring Road Kilimani and end at junction with Ole Odume road. The walkway between Ralph Bunch Road and Valley Road would also be constructed/ maintained. The total length of the road is 2.1Kms.

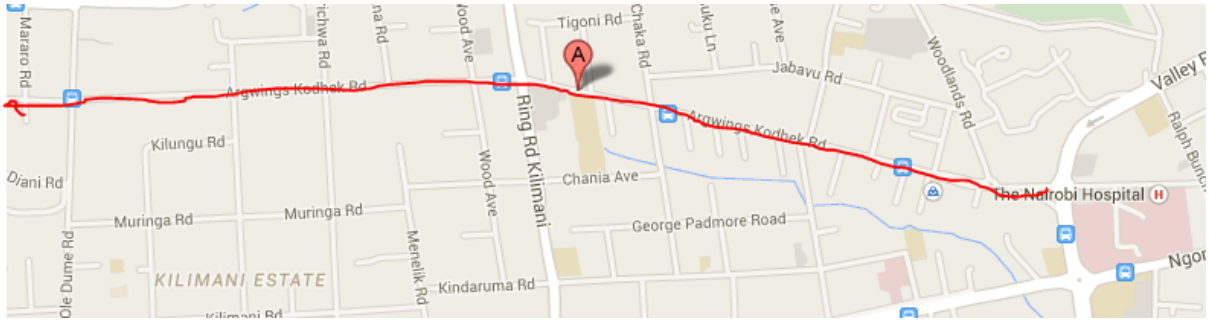


Figure 4.6: location of argwing Kodhek road

The road is an important link within Hurlingham/Kilimani area and provides access to business properties and residential estates within the area. The locational map is attached in appendix.

The contract sum was KShs.42,942,417.00

4.3.3 Mang'u-Gatundu-Ichaweri (C64) ROAD

The works are not located within Nairobi county but within the jurisdiction of KeNHA Nairobi region. The total length of the road is 18.5 KMs**.**

The road is an important link within Mang'u to Ichaweri through to Gatundu areas and provides mobility for the farmers within the area as it's an agricultural zone. The contract sum was KShs.24,791,008 which were well less than the estimated budget of 29,839,019.

At the time of the reporting, 17.12 percent of the works had already been done as per the Engineer's progress report. The physical works progress has been attached in annex

Figure 4.7: section of Mang'u-Gatundu-Ichaweri (C64) ROAD

Figure 4.8: section of MANGU-GATUNDU-ICHAWERI (C64) ROAD

It should be noted that all the sample roads were contracted as **Admeasurement contracts**. This is whereby items of work are specified in Bills of Quantities or Schedule of Rates. The contractor then specifies rates against each item.

4.3.4 Challenges faced on site

1) Nairobi drainage system. Roads conditions deteriorate at much higher rate in rainy and wet conditions. This means that if the drainage has not been effective as was designed to be the road will deteriorate faster.

The sewer system leak more often due to overburden. They cannot handle the flow as they are old and their design capacity is less than what the capacity they are expected to handle now. This according to the discussion with all the Regional Managers.

Figure 4.10: leaking sewer on BH road

Figure 4.11: clogged up drain on BH-Road

2) Encroachment. Land which was previously set aside for road construction has been encroached and occupied by the residents and this is more common in slum areas according to the KeRRA regional manager. Mathare BH road is a good example. These means that there is no road before maintenance. When maintenance works are scheduled, the resident demands compensation before they can move. Compensation which is both unlawful and has not been factored in the work plan.

Figure 4.12: "mama mboga" selling on the BH road

3) Damping of wastes. Damping has been a big problem according to the RM's. When it is done on the drainage system, it clog's it up. If the drains are not cleaned on time then the road condition starts to deteriorate.

Figure 4. 2 a man going to dump his waste on the road and a heap of waste as removed from the drain

4) Lack of public sensitisation. The public may not clearly understand the importance of certain road elements like the drains. In case of C64, one member of the public clearly blocks a drain with heap of soil to provide access to his homestead.

Figure 4. 3 section of the drain being blocked by heap of soil

4.4 ROAD CONDITION REPORT

No agency or the Nairobi County Government has been able to carry out ARICS for the years under review. Only the KRB ARICS report published in 2012 was available to depict the picture of the road network condition at the time of study. This has been attributed to high cost required to carry out the exercise.

The Kenya National Highways Authority (KeNHA) carries out International Roughness Index (IRI) as their measure of the road surface condition. This is considered more affordable for the agency. However, the IRI is only carried out on few roads out of their network, with a view of carrying out the whole network in 3-4 years.

The Kenya Urban Roads Authority (KURA) has not carried out any ARICS in recent past. They have roads permanently on their work programs. They access the maintenance needs by use of visual ratings, which the senior engineer is in-charge of. From the physical needs observed money is allocated according to those needs. However, not all needs are captured as the agency must not leave any road out of the work program.

The Kenya Rural Roads Authority (KeRRA) also has no record of any ARICS done in the years under review. The constituency roads committee (CRC) is involved in the prioritization of funds and the roads/road sections to be allocated. The authority conducts a site visit and collects necessary data on the road surface condition.

The county government department has not collect road condition and inventory survey in the years under review. They have other parameters to guide them in prioritization of works and fund, this according to the engineer. The department has a database of all the roads in the county and try as much as possible to be equitable among all the 17 constituencies. They also give priorities to the prone areas; this are areas that get deteriorate more easily do to natural causes such as weather. Recently they conducted a programme dubbed *medium- term expenditure* in the month of January 2015. It involved going to all the wards conducting public forums and getting the views of the public. According the Engineer in-charge, it was in fulfilment of new constitution requirement on public participation and public involvement in decision making. The prioritization will therefore be according to what the public demands

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The importance of Road Maintenance has been highlighted in the preceding sections of this study, but for a variety of reasons, road maintenance is rarely carried out effectively as opposed to road design, planning and construction which are usually carried out to the highest standards.

From the study, it was concluded that:

1) Provision of satisfactory road maintenance still remains an elusive goal for Nairobi. More resources need to be channelled to maintenance as it's the only sure way of having the road network in satisfactory surface conditions.
2) The Nairobi City County did not have clear policies on road maintenance and did not have any road maintenance management system.
3) The drainage system was one of the major causes of road deterioration.
4) There was no public involvement in road maintenance.
5) The current form of contracting is overtaken by time.

5.2 Recommendations

The study came up with the following recommendations to improve road maintenance in Nairobi City County:

Financial requirement

Currently the amount allocated representing 40% of what is required shows that, there is still a lot of deficit leading to backlog of the maintenance works. Kenya Roads Board needs to come up with more innovative ways of raising more funds. This is in addition to the already existing fuel levy. This may include tolling more roads.

The county government needs to allocate more funds to road maintenance. The current allocation is NOT proportionate to the works that need to be carried out.

Policy developments

In setting policies and criteria, the County government must make clear distinction between routine maintenance, periodic maintenance and rehabilitation. Also there should be a clear network approach and budget in place.

Road maintenance management system

The county government should embrace the RMMS system already being used by the agencies. This would make their planning, allocation of funds and appraisal of the ongoing project more efficient than the manual system they operate.

Another aspect of improvement is directly related to the system itself. By incorporating the reporting feature in the system, the operators are able to analyse and view the current condition of the road. For example use of GIS to show the current road condition.

Road condition reporting

Regular and adequate reporting on road conditions should receive more emphasis to enable realistic maintenance schemes to be drawn up. More funds should be channelled to annual road inventory and condition surveys.

The public themselves should be have ways the can use to report on defects they can observe as early as possible. This makes it easier for maintenance works to be scheduled early enough hence minimizing cost.

Improvement of the drainage system

One of the major problem as cited by all who were interviewed was a poor drainage system which was blamed for the high cost of maintenance. Natural occurrences such as weather cannot be avoided. Therefore there is need to improve the current drainage system. This will reduce the rate of deterioration of the roads.

Public partnership

The agency should pursue public partnership with the local people to do some maintenance works such as ditch cleaning. This is can be well undertaken by a road such as BH ROAD. The road passes through a slum area where the residents have encroached. They can be mobilized to do activities like ditch cleaning.

The resident can be mobilized to report defects such as potholes in case of C64 or where there is a defect in BH road. With timely reporting and appropriate action being undertaken on time, the road can be kept to acceptable level throughout the year.

Performance based contracts.

One the radical changes taking place is moving from now out-dated system of contracting to more effective performance based system. It may be considered more costly but makes sure that routine maintenance is done routinely. These makes the contractors always have his presence on the road every day for the whole contract period.

REFERENCES

1. Dr. Ahmad Ramly (2002). *PrinsipdanPraktisPengurusanPenyenggaraanBangunan. PustakaIlmi,* Selangor
2. www.krb.go.ke
3. N.W. Mohamed (2010). Road Maintenance Management System: a case study at public work department
4. British Standard Institution (1984). Maintenance management terms in teratechnology. BS3811:1984
5. Muhammad Suhail Badrul amal, Majdi Mohamad, Nafisah Abdul Aziz (2002),Privation of Maintenance for Federal Roads in Peninsular Malaysia. 5th Malaysia Road Conference, 7 -9 October 2002, Kuala Lumpur
6. www.wipendia.org/wiki/road
7. 506 bureau of Indian affairs manual
8. Dr. Gunter Zietlow (2004), Implementing Performance-based Road Management and Maintenance Contracts in Developing Countries - An Instrument of German Technical Cooperation
9. Transport Note No. TRN-4 (2005)
10. An OECD Scientific Expert Group (1995). Road Transport Research, Road Maintenance Management system in developing countries
11. Haas, R. and Hudson, W. R., *Pavement Management Systems*, McGraw-Hill, New York, 1978
12. Tillotson, H.T., Kerali, H.R. and Snaith, M.S., *Proceedings of the International Symposium on Infrastructure of the Future*, New Age International (P) Ltd, Bangalore, 1996, pp. 220 – 227.
13. "Draft policy on aligning the roads sub-sector with the constitution", September (2012), Republic of Kenya.
14. "Roads 2000 strategic plan 2013 – 2017", Republic of Kenya.
15. Wilson S.K. Wasike (2010) Road Infrastructure Policies in Kenya: Historical Trends and Current Challenges
16. Public Roads Toll Act (1989)
17. Dr. Emad Elbeltagi (2012), Construction Management
18. Auditor general for Scotland and the account commission report (2011)

19. Dr. (Mrs.) S.O. Alade, Central Bank of Nigeria Research Department (2003) “highway maintenance in Nigeria: Lessons from other countries
20. Class notes
21. Kenya public road toll act (1984)
22. www.businessadvocasy.com

APPENDIX 1

Table 6.1: units for maintenance program

Description	**unit**
Cut to spoil in soft	Cubic metres
Base repair with quarry chips	
Pothole patching with premix	
Ditch cleaning	Metric tonnes
Manual road markings	
Kerb construction	number
culvert installation	
Gully cleaning	
Traffic signs replacement	

APPENDIX 2

APPENDIX 3

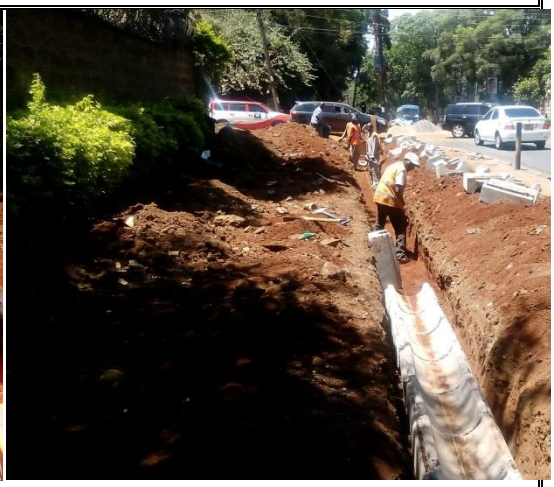
Summary of Physical Progress of Major Construction Activities

Bill Item	**Description of work**	**Unit**	**Scope**	**Work Done**		
			%	Previous (%)	This Period (%)	% Completed To date
1	Preliminaries and General items		100	30	10	40
4	Site clearance and topsoil stripping		100	70	10	80
5	Earth Works		100	80	6	86
8	Culverts and Drainage works		100	40	40	80
9	Passage of Traffic		100	16	16	32
11	Shoulders to Pavement		100	40	5	45
12	Natural material sub-base and base		100	50	20	70
15	Bituminous surface treatment and surface dressing		100	50	20	70
16	Bituminous mixes		100	50	20	70
20	Road Furniture		100	40	20	60
Overall progress in %			100	**50**	35	85

The contract provision and amount certified to date

Bill No.	DESCRIPTION	Contract Amount (Kshs.)	Appraised Amount (Kshs.)
1	Preliminary and Supervisory/Support Services	2, 515,000.00	1,290,000.00
4	Site Clearance and Topsoil Stripping	84,000.00	60,000.00
5	Earth Works	233,000.00	112,000.00
8	Culverts and Drainage Works	2,191,000.00	1,371,920.00
9	Passage of Traffic	126,000.00	27,000.00
12	Natural Material Sub-base and Base	2,644,000.00	585,104.00
15	Bituminous Surface Treatment and Dressing	4,626,000.00	1,551,769.60
16	Bituminous Mixes	20,288,000.00	13,741,293.00
20	Road Furniture	2,549,500.00	393,000.00

SITE PHOTOGRAPHS AND THEIR DESCRIPTION

	
Excavation for culvert installation	Laying and joining of precast pipe culverts
	
Excavation and levelling to IBDs	Laying and joining of IBDs

	
Laying of precast pipe culverts	Reinforcing headwalls and wing walls
	
Spraying of k1-60 as tack coat.	A section after overlay with AC
	
Excavation and levelling for kerbs installation	Kerbstone installation in progress

APPENDIX

APPENDIX 3: PHYSICAL WORK SUMMARY FOR ROUTINE MAINTENANCE OF MANGU-GATUNDU-ICHAWERI (C64) ROAD as at 28TH/FEB/ 2015

	Item Code	Description	Unit	Quantity	Bill Item Amount (Kshs)	Till Previous Period		This Period		Done To Date		Bid Rate	Upto Date Value of Work	Project Weight	% Weigjted Progress
						Quantity	%	Quantity	%	*Quantity*	*%*				
1	01-80-010	Allow a prime cost sum for material testing as directed by Engineer	Pc sum	50,000	**50,000**		0.00		0.00	*0.00*	*0.00*	1	**0.00**	0.002	0.00
	01-80-011	Extra over of 01-80-010 for contractors overheads and profits	%	50,000	**5,000**		0.00		0.00	*0.00*	*0.00*	10%	**0.00**	0.000	0.00
	01-80-016	Provide and erect publicity signs as directed by the Engineer	NO.	2	**160,000**		0.00	2.00	100.00	*2.00*	*100.00*	80,000	**160,000.00**	0.006	0.65
	01-80-017	Provide fuel and maintain with drivers 2 No new 4WD double cabin (adometer:0 - 10000)	V/Months	6	**1,800,000**	1.27	21.17	0.00	0.00	*1.27*	*21.17*	300,000	**381,000.00**	0.073	1.54
	01-80-018	Extra over 01-80-017 for mileage over 4,000km	KM	2,400	**55,200**		0.00		0.00	*0.00*	*0.00*	23	**0.00**	0.002	0.00
	01-80-026	Allow a prime cost sum for Engineers Miscellaneous account	Pc sum	200,000	**200,000**		0.00		0.00	*0.00*	*0.00*	1	**0.00**	0.008	0.00
	01-80-027	Extra over of 01-80-026 for contractors overheads and profits	%	200,000	**20,000**		0.00		0.00	*0.00*	*0.00*	10%	**0.00**	0.001	0.00
	01-80-030	Allow a Prime cost for attendance to the RE,s supervisory staff including overtime	Pc sum	800,000	**800,000**		0.00	32,500.00	4.06	*32,500.00*	*4.06*	1	**32,500.00**	0.032	0.13
	01-80-031	Include percentage of Pc sum Item 01-80-030 for overheads and profit.	%	800,000	**80,000**		0.00	32,500.00	4.06	*32,500.00*	*4.06*	10%	**3,250.00**	0.003	0.01
4	04-50-003	Heavy Bush Clearing	m^2	80,000	**560,000**	54,435.65	68.04		0.00	*54,435.65*	*68.04*	7	**381,049.55**	0.023	1.54
5	05-60-002	Fill in soft material including benching of shoulders and embarkment and compact to 95% MDD in layers of 150mm	m^3	55	**16,500**		0.00		0.00	*0.00*	*0.00*	300	**0.00**	0.001	0.00
7	07-60-001	Excavate and back fill for gabions in soft materials	M^3	300	**120,000**		0.00	68.50	22.83	*68.50*	*22.83*	400.00	**27,400.00**	0.005	0.11
	07-60-002	Provide and place gabion boxes and mattresses as specified or as directed by the Engineer	M^2	660	**363,000**		0.00	650.00	98.48	*650.00*	*98.48*	550	**357,500.00**	0.015	1.44
	07-60-003	Provide and place rock fill to gabions and mattresses	M^2	120	**180,000**		0.00	130.00	108.33	*130.00*	*108.33*	1,500	**195,000.00**	0.007	0.79
	07-60-004	Allow for grouting of the rock fill where necessary	M^2	126	**12,600**		0.00	82.83	65.74	*82.83*	*65.74*	100	**8,283.00**	0.001	0.03
	07-60-005	Provide and place 200mm thick stone pitching including grouting	M^2	300	**300,000**	48.20	16.07	35.00	11.67	*83.20*	*27.73*	1,000	**83,200.00**	0.012	0.34
8	08-50-005	Ditch/ Mitre Drain Catch water excavations and carting away	m^3	300	**90,000**		0.00	111.06	37.02	*111.06*	*37.02*	300	**33,318.00**	0.004	0.13
	08-60-003	Culvert Cleaning- Partially blocked-600mm	MT	250	**75,000**		0.00	95.00	38.00	*95.00*	*38.00*	300	**28,500.00**	0.003	0.11
	08-90-003	Excavation in soft material for pipe culverts, headwalls, wingwalls, apron, toe walls and drop inlets	M3	150	**45,000**		0.00		0.00	*0.00*	*0.00*	300	**0.00**	0.002	0.00
	08-90-016	Clean side drains, outfall, catch water, mitre drains and cut off drains to free flow conditions	M^3	3,500	**1,050,000**	110.25	3.15	50.00	1.43	*160.25*	*4.58*	300	**48,075.00**	0.042	0.19
11	11-50-001	Shoulder grading	M2	2,290	**27,480**	5,131.50	224.08	0.00	0.00	*5,131.50*	*224.08*	12	**61,578.00**	0.001	0.25
	11-50-003	Provide,place and compact natural gravel to shoulders	M3	750	**1,012,500**		0.00	160.00	21.33	*160.00*	*21.33*	1,350	**216,000.00**	0.041	0.87
12	12-60-001	Base Repair - Hand Packed Stone	M^3	20	**40,000**		0.00	10.93	54.65	*10.93*	*54.65*	2,000	**21,860.00**	0.002	0.09
15	15-50-002	Prime Coat	L	150	**15,000**		0.00	95.42	63.61	*95.42*	*63.61*	100	**9,542.00**	0.001	0.04
	15-50-003	Tack Coat	L	5,500	**550,000**		0.00	2,278.51	41.43	*2,278.51*	*41.43*	100	**227,851.00**	0.022	0.92
	15-60-004	Provide, spread and roll 10/14 mm precoated chipping	M^3	800	**2,800,000**		0.00		0.00	*0.00*	*0.00*	3,500	**0.00**	0.113	0.00
	15-92-002	Provide, heat and spray 80/100 pen grade bitumen for 1st seal on carriageway	L	75,000	**6,000,000**		0.00		0.00	*0.00*	*0.00*	80	**0.00**	0.242	0.00
16	16-50-001	Pothole Patching -hot mix	m3	150	**3,750,000**		0.00	76.99	51.33	*76.99*	*51.33*	25,000	**1,924,750.00**	0.151	7.76
	16-80-001	Provide, lay and roll asphalt concrete type 1 (bitument content 5-6% by weight)	M^3	90	**2,250,000**		0.00		0.00	*0.00*	*0.00*	25,000	**0.00**	0.091	0.00
	16-80-004	Clearing and cutting of potholes	m3	220	**110,000**		0.00	89.13	40.51	*89.13*	*40.51*	500	**44,565.00**	0.004	0.18
		Sub Total			**22,537,280**								**4,200,656.55**		
		Contigencies (@ 10%)			**2,253,728**								**Progress to Date**		**17.12**
		TOTALS			**24,791,008**										