ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Study of Performance Based Road Maintenance Contracting System for Ethiopian Federal Roads

By: Biniyam Regassa

Advisor: Prof.Dr.-Ing. Abebe Dinku

A Thesis submitted to School of Civil and Environmental Engineering, Addis Ababa University, Addis Ababa Institute of Technology, for partial fulfillment of the requirement of Master of Science Degree in civil Engineering
(Construction Technology and Management)

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This thesis is my original work, was not copied, has not been presented for a degree in any other university, and all the sources used have been duly acknowledged.

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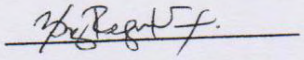

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LIST OF ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
ASCE	American Society of Civil Engineers
CREMA	Contracts for Rehabilitation and Maintenance
EFY	Ethiopian Fiscal Year
ERA	Ethiopian Roads Authority
ERCC	Ethiopian Road Construction Corporation
FHWA	Federal Highway Agency
FRE	Finish Road Enterprise
GDP	Gross Domestic Product
KRE	Knish Road Expertise
LOS	Level of Service
MAC	Managing Agent Contract
MQA	Maintenance Quality Assurance
NCHRP	National Corporative Highway Research Program
NPV	Net Present Value
NZ	New Zealand
PBC	Performance Based Contracts
PBMCs	Performance Based Maintenance Contracting System

PSMC	Performance Specified Maintenance Contracts
QBS	Qualification Based Selection
QC	Quality Control
RFPs	Request for Proposals
RFQs	Request for Qualifications
RMI	Road Maintenance Initiative
RMP	Road Maintenance Project
RSDP-I	Road Sector Development Program One
SANRAL	South African National Road Agency
SNNP	Southern Nation's Nationalities People
UK	United Kingdom
USA	United States of America
VOC	Vehicular Operating Cost
WRA	World Road Association

ABSTRACT

Performance Based Road Maintenance Contracting System (PBMCs) is a new way of contracting road maintenance projects used in most developed and some developing countries. The reduction of road maintenance costs and improvement of contracted road assets has been a challenge in Ethiopian road maintenance industry. This research was designed to study performance based road maintenance contracting system for Ethiopian federal roads and to assess the current contractual practice while identifying the status of contracted federal roads. Case studies of contractual practices in the ten road maintenance projects from July 2013 to June 2014, supported by semi structured interview and 10 years of recorded documents were used for the study. The results of case studies conducted on the ten road maintenance districts indicated that out of the 49 routine and periodic road projects investigated, 30 projects (62.5%) suffered cost overrun while 15 projects (30.6%) suffered cost under run in their execution. For these maintenance projects, the average cost overrun was found to be 18% of the contract amount, the actual cost overrun ranging from -100% to 140 %.The results also revealed that the current road maintenance industry is suffering from expenditure uncertainty and poor condition of road assets. Moreover, it was found that the activity unit rates for routine and periodic maintenance projects have not been revised for the last eight years. Thus, road maintenance community in the country could benefit from proper implementation of PBMCs and the revision of activity unit rates.

Key Words: *Case Study, Ethiopia, Federal Roads, Road Maintenance*

1. INTRODUCTION

1.1 Background

Roads are essential to a country‟s economic and social development. For most sectors of the economy, they form vital links between production centers and markets. Their multiple function of providing access to employment, social and health services and education makes them key elements in the fight against poverty by opening up rural areas and stimulating economic and social development.

Olivier *et al.* (2002) stated road maintenance as a fundamental necessity, as important as original road provision. But for reasons that are difficult to assess, road maintenance is often viewed as an activity that is carried out only when the road is damaged. As no one would apply this approach to his house or even his own health, it is strange that it seems to be a pervasive attitude in the road sector. The situation is particularly critical with unsealed roads, which is the case with the majority of provincial, district and commune roads.

According to Heggei and Vickers: World Bank (1998), roads are among the most important public assets in many countries. Road improvements bring immediate benefits to road users through improved access to hospitals, schools, and markets; improved comfort, speed, and safety; and lower vehicle operating costs. For these benefits to be sustained, a well-planned program of maintenance must follow road improvements.

The failure to maintain roads is tantamount to an act of disinvestment, for it implies the sacrifice of past investments in roads. According to the study carried out by The World Bank in the eighty-five developing countries an estimated $45 billion worth of road infrastructure has been lost over the past two decades owing to inadequate maintenance. This loss could have been averted with preventive maintenance costing less than $12 billion (Harral and Faiz, 1988).

According to Heggie and Vickers: World Bank (1998), maintenance reduces the rate of pavement deterioration. It lowers the cost of operating vehicles on the road by improving the running surface and it keeps the road open on a continuous basis.

The traditional way of contracting out road maintenance is based on the amount of work being measured and paid for on agreed rates for different work items. These are also referred to as unit price contracts.

According to NCHRP (2009), Performance-Based Maintenance Contracting (PBMC) is a contracting method that provides incentives and/or disincentives to the contractor to achieve desired outcomes or results; in its purest form, PBMC does not detail how, when, or where to do the work. Performance-Based Road Management and Maintenance Contracts define minimum conditions of road, bridge, and traffic assets that have to be met by the contractor, as well as other services such as the collection and management of asset inventory data, call-out and attendance to emergencies, and response to public requests, complaints and feedback (Zietlow, 2005).

In the highway arena, where low-bid contracting combined with method specifications has been the norm for most of the twentieth century, PBMC represents a departure from standard practice. Based on increasing experience with PBMC around the world, PBMC has much to recommend it. This approach to contracting is not a panacea, it is not universally accepted, and failure might occur. However, transportation agencies see it as an important option to consider and a valuable or potential instrument in their contracting tool kit.

Ethiopia has a total of around Forty Five thousand kilometers of road to be maintained and is caring out a maintenance work on an average of twenty thousand kilometers annually by the Federal Road Agency. Though the current status of the country towards maintenance of road is showing glimpse of development, there is still a lot of work to be done in order to improve the road network (ERA,2014).

The research will study performance based road maintenance contract in Ethiopian Federal roads, since it is a new road maintenance contracting method for the current practice of the road maintenance in the country. It will further assess the current contractual road maintenance practice, the draw backs in implementing PBMC and the potential outcomes expected from the system.

1.2 Statement of Problem

According to data obtained from Ethiopian Road fund financial report (2013), with an excess of 1 Billion Birr has been spent for federal road maintenance in 2013 but still nearly half of the road network in the country is regarded as „Fair and Good" state. According to Zietlow (2005), the principal advantage of contracting out road maintenance based on performance indicators is its potential for reducing road maintenance costs and improving road conditions.

Ethiopia Currently uses Traditional method of contracting System (Contracting unit Rate) for Road Maintenance Projects.

1.3 Significance of the study

I. Implementing proper road maintenance saves the countries budget and time spent on reconstruction.
II. Proper maintenance enhances the safety of passengers while reducing operating cost for vehicles.

1.4 Scope of the study

The scope of the study is limited to the study of federal road maintenance contracts, status of contracted road assets and road maintenance costs of projects under the ten road maintenance districts in Ethiopian federal roads. The study has focused on the road segments contracted under routine and periodic projects for the year 2013/2014 supported by ten years of recorded documents. Thus, specific techniques for road maintenance are not analyzed in detail.

1.5 Research Questions

I. Is the current road maintenance contractual practice implemented in Ethiopia Satisfactory?
II. Can PBMCS be a solution in improving the federal roads in the country?
III. What are the major drawbacks in implementing performance based contracting system for the maintenance of federal roads in Ethiopia?
IV. What are the lessons to be learned from other countries in implementing performance based contracting system in road maintenance?

1.6 Research Objectives

I. To study the existing practices of road maintenance contracts, costs and status of the road condition in Ethiopian federal Roads.
II. To study performance based contracting system for Ethiopian federal roads.
III. To identify the major drawbacks in implementing performance based contracting system for the current federal road maintenance in Ethiopia.
IV. To learn from experience of others who have previously implemented performance PBMCs.
V. To forward recommendations based on the findings of the study

1.7 Research methodology

The research strategy adapted for this research is qualitative research of exploratory type, which diagnoses a situation, assess alternatives, and discover new ideas. The methodology followed for the research is described here under:

I. **Establishing the basis of the research**: aimed at defining the theoretical basis, and formulating the research questions through the following steps.

- Literatures were reviewed to obtain a theoretical basis for the research and formulating the research questions and defining the scope. To this effect, the main authors of textbooks in the field of road maintenance and performance based contracting system were identified. The books were then reviewed in order to get a general understanding of the research area.

- Interview schedule was prepared based on the findings of the literature review.

II. **Conducting the study**: aimed at finding out how road maintenance contracts are implemented in Ethiopian federal roads with the following approach.

- A case study of how road maintenance contracts are used in contractors engaged with road maintenance, Mainly Ethiopian Road Construction Corporation (ERCC) was studied.
- A desk study to get a picture of road maintenance contracts both at international and local level was studied.
- Interviewing key informants (Road Asset Management D/Director, Road fund D/Director, Road maintenance division Manager and project managers of districts and Contractors and Contract Administration, ERA) to get in-depth understanding of contracting system in road maintenance being practiced, and to explore their opinions on the ongoing road maintenance practice.

III. **Analyzing the findings**; aimed at analyzing the findings of case study and desk studies in relation to theoretical propositions, and that of the interview using descriptive statistics method of analysis.

IV. **Conclusions and Recommendations**: aimed at concluding the research findings, and drawing recommendations (Figure 1.1).

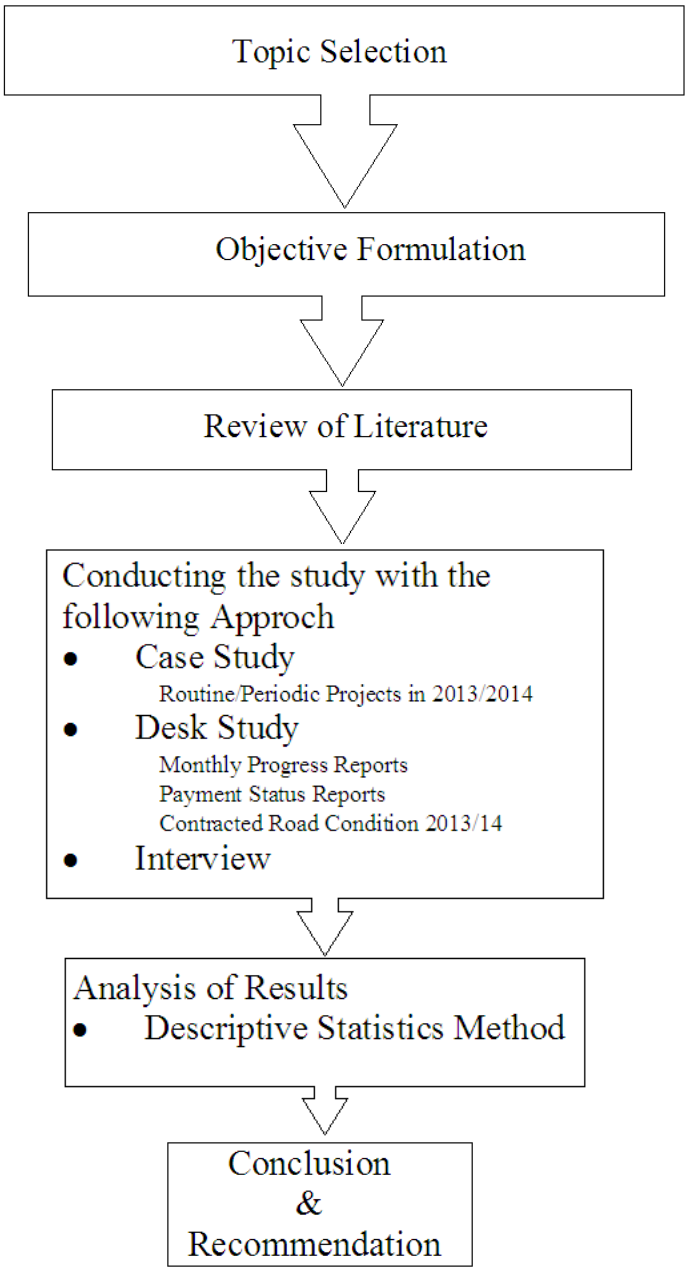


Figure 1.1: Research Design.

1.8 Contribution of the research

The results of the research will discover whether or not performance based road maintenance contract in Ethiopian Federal roads can be successfully implemented and be a solution for the current practice of the road maintenance in the country. Furthermore, the study will give a brief description of performance based road maintenance contracting system, as it is a new concept in Ethiopian road maintenance industry.

2. LITERATURE REVIEW

2.1 Introduction

According to Mohammed (2010), citing Ahmad (2002) 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; a budget allocated for construction work is usually given a prior consideration. However, it is a fact that maintenance is the most important activity, which is carried out to prolong or at least maintain serviceability of structure until the end of its service life.

Harral and Faiz (1988), noted that the developing world‟s road-building boom in the 1960s and 1970s that led to a significant development of road infrastructures; threaten to collapse, if not maintained accordingly. The cost of restoring or reconstructing these deteriorated roads is going to be three to five times greater than the bill would have been for timely and effective maintenance and strengthening. Furthermore, the current state of the economy imposes limitations on the money available for investments in roads and their maintenance. Thus, there must be a more stringent control on the planning and the management of the road maintenance system.

Reducing maintenance costs and providing timely improvement of transportation facilities are the major goals of public transportation agencies for the preservation of the existing infrastructure. Performance-Based Road Management and Maintenance Contracts define minimum conditions of road, bridge, and traffic assets that have to be met by the contractor, as well as other services such as the collection and management of asset inventory data, call-out and attendance to emergencies, and response to public requests, complaints and feedback (Zietlow, 2005).

Performance-Based Maintenance Contracting (PBMC) was first implemented on a wide scale in British Columbia and since then has become a mainstay of maintenance contracting in Australia, New Zealand, England, and Finland, and to an increasing degree in other countries, including the United States, Chad Tanzania and South Africa (NCHRP 2009).

2.2 General Overview of Road Maintenance

Before assessing the situation in Road Maintenance practices, it is important to address the issue of the term "maintenance". The basic objective of road maintenance is implicit in the word itself. It is done to ensure that the road that has been constructed, or improved, is maintained in its original condition. It is accepted that over the life of the road it will deteriorate due to factors with which maintenance activities cannot deal. Nevertheless maintenance is intended to begin on the first day after the road improvement works are completed.

2.2.1 Maintenance definition

According to Haas (1978), the definition of maintenance varies among agencies. In a physical sense, maintenance consists of a set of activities directed towards keeping a structure in a serviceable state. For pavement, this includes such work as patching, resurfacing, crack filling and so on. The following are some definition of maintenance from different sources.

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. There are two types of maintenance involving repairing work and 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 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.

2.2.2 Road maintenance definition

According to the ASCE (1971), road maintenance is defined under two subdivisions: physical maintenance and traffic services. Physical maintenance is the preservation and upkeep of a highway, including all of its elements, in as nearly as practicable its original, as-constructed condition or its subsequently improved condition." Traffic services are defined as "the operation of a highway facility and services incidental thereto, to provide safe, convenient, and economical highway transportation."

AASHTO (1976), defined highway maintenance as a program to preserve, repair and restore a system of highways with its elements to its designed or accepted configuration. System elements include travel way surfaces, shoulders, roadsides, drainage facilities, signs, markings, lightening, fixture etc.

World Road Association (1994), defined road maintenance as "activities to keep pavement, shoulders, slopes, drainage facilities and all other structures and property within the road margins as near as possible to their as-constructed or renewed condition" It includes minor repairs and improvements to eliminate the cause of defects and to avoid excessive repetition of maintenance efforts. Maintenance does not include rehabilitation, building shoulders, or widening roads. Haas (1994) defined road maintenance as a set of preventive activities directed towards limiting the rate of deterioration of a structure or corrective activities directed towards keeping the road in a serviceable state.

Tyler and Francis (2006) defined road maintenance as an action taken to retain the road pavement in a safe and useable condition. Road maintenance normally excludes upgrading and strengthening of the road elements, but may be done if these appear to be the most cost effective actions in the long terms.

Regarding to Ethiopian Roads Authority (2003), road maintenance is defined as routine, periodic and emergency works to keep pavements, shoulders, slopes, drainage facilities and structures in as near as possible to their as constructed or renewed condition to ensure its design life is attained.

2.2.3 Importance of road maintenance

Roads are of vital importance in order to make a nation grow and develop. There is however a problem, common throughout the world, of neglecting the maintenance of roads. Building new roads costs money, but without properly maintaining the roads, they deteriorate very quickly. If nothing is done, roads with a design life of decades may need replacing or major repair work after just a few years (Levik, 2003).

According to Heggei and Vickers (1998) roads are among the most important public assets in many countries. Road improvements bring immediate benefits to road users through improved access to hospitals, schools, and markets; improved comfort, speed, and safety; and lower vehicle operating costs. For these benefits to be sustained, a well-planned program of maintenance must follow road improvements. Without regular maintenance, roads can rapidly fall into disrepair, preventing realization of the longer-term impacts of road improvements on development, such as increased agricultural production and growth in school enrollment **(**SANRAL, 2004**).**

Too often, decision makers are left unaware of the importance of road maintenance because justification for funding is based only on a narrow range of considerations and is not described in terms of the impacts on users and wider society. But maintenance often offers some of the best returns for investment in the transport sector. For example, recent plans for renewal and expansion of USA‟s infrastructure (Department of the Treasury, 2012) quoted earlier economists: „some types of highway investment still seem highly desirable, such as plain old maintenance‟.

According to Zietlow (2007), when roads are in poor condition every $ “saved” in road maintenance will cost: $ 3 to road users in additional to vehicle operating costs and $ 2 to the road administration (or the tax payer) in reconstruction and rehabilitation. According to Heggie and Vickers: World Bank (1998), maintenance reduces the rate of pavement deterioration. It lowers the cost of operating vehicles on the road by improving the running surface and it keeps the road open on a continuous basis. Robinson *et al.* (1998), in their book „Road Maintenance Management Concepts and Systems „stated the importance of maintenance as the following;-

I) **Reducing Deterioration**: Eventually the end of pavement design life will be reached and there is a need for pavement reconstruction or upgrading. These are normally relatively expensive and should be postponed for as long as possible carrying out effective and timely maintenance.

II) **Lowering Vehicle Operating Cost**: Robinson (1998), explained that the relative proportions of road administration costs and vehicle operating costs in the total life time transport cost with road vary depending on the traffic level. The relative proportion of vehicle operating cost rises from about 40 percent at 50 vehicles per day to over 90 percent at 6000 vehicles/day. For a good condition road having a traffic level of about 1000 vehicles/day requires 2% of discounted cost to be spent on maintenance. However if maintenance funds are reduced, the pavement will start to crack and potholes will gradually appear and with these levels of deterioration, vehicle-operating costs are likely increase by about 15 percent. If there is complete neglect of maintenance, a paved road will eventually start to disintegrate and annual vehicle operating cost will increase by about 50 percent.

III) **Keeping the Road Open**: Robinson (1998), explained the third reason for carrying out maintenance as to keeping the road open continuously. Since their closure for whatever reason causes potentially serious social and economic consequences.

IV) **Safety**: Accidents have proved to be an inevitable result of road transport and deaths and injuries are very tangible impacts of the roads on the community. Road maintenance works can often provide an opportunity for improvement of road safety by contributing engineering factors in the areas of pavement and foot way surfaces, carriageway markings and signs, streetlights and road furniture

V) Environmental Issues; - the conditions of roads affect the environment (World Bank 1994).

A study made by international labor organization on rural road maintenance (2007), cited Road Maintenance as an important because it:

I. prolongs the life of the road by reducing the rate of deterioration, thereby safeguarding previous investments in construction and rehabilitation,

II. lowers the cost of operating vehicles on the road by providing a smooth running surface

III. keeps the road open for traffic and contributes to more reliable transport services
IV. Sustains social and economic benefits of improved road access.

The first purpose is primarily in the interest of the responsible government authorities. The last three are of more general interest to the inhabitants of the area traversed by the road and to the vehicle operators.

Olivier *et al.* (2002), listed importance of maintenance into four categories;

I. First, various Acts of parliament place legal obligation on road authorities to maintain their roads in a safe condition and insure that maintenance operations are carried out safely.
II. Second, roads are very often the „vehicles" for caring the apparatus of statutory undertakers. Example, electricity, gas, water and telephone and maintenance of this equipment are also controlled by statue.
III. Third, well-maintained roads support national and local economies by ensuring that freight and businesses can move efficiently and safety.
IV. Fourth, the way of life in developed countries defends substantially on the availability of road network. The vast majority of trips to schools, shops, hospitals and leisure activities are made via the road network.

Mohammed (2010), in his thesis work, revealed the importance of road maintenance into three different aspects. These are:

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 compared to reparation and renovation.

II. Cost

Definitely the costs required by maintenance are lesser than the 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 the benefit 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.

2.2.4 Objective of Road Maintenance

According to Linard (2000), the objective of road maintenance is to make the road safe and smooth. The rationale for road maintenance is clear. The basic objective is implicit in the word itself. It is done to ensure that the road that has been constructed, or improved, is kept in its original condition. It is accepted that over the life of the road it will deteriorate due to factors that maintenance activities will need to address. Maintenance is organized as a preventive measure and for this reason starts from the day the road improvement works are completed (International labor Organization, 2007).

The main objective of highway maintenance is to maintain the highway network for the safe and convenient movement of people and goods. The core objectives of highway maintenance are to deliver a safe, serviceable and sustainable network, taking into account the need to contribute to the wider objectives of asset management, integrated transport, corporate policy and continuous improvement (Well-maintained Highways-code of practice, 2011). Dipak (2005), conducting a study for roads maintenance at Nepal found that the main objectives of road maintenance is to ensure the serviceability of the road network and minimize the cost of road transportation, which is comprised of agency cost (capital cost of construction and maintenance of the facilities over their design life) and road user cost.

A study made by international labor organization (2007), revealed that the objective of road maintenance is ensuring that the road remains serviceable or at least to sustain the life of the road by putting off the date at which it needs to be reconstructed. This has several benefits, the most important being that it stretches the period over which the benefits of the investment made are available and therefore provides a higher rate of return on the initial investment. In addition, it puts off the date when large investments are required for reconstructing the road.

According to Travis (2013), the major objectives of a road maintenance program include the following:

- Maintain all highway features and components in the best possible condition
- Improve substandard features, with the ultimate goal to at least meet minimum standards
- Provide proper maintenance devices for a minimum of traffic disruptions and/or hazards to traffic
- Locating and reporting of inadequate safety features
- Identify needs
- Establish priorities
- Establish procedures
- Establish and maintain a regular program of maintenance for all aspects of highway maintenance

Haas (1994), summarized the objective of road maintenance as follows:

I. to plan, direct and control maintenance activities so that an acceptable level of service, consistent with the class of pavement is achieved.

II. to evaluate the methods and materials used in maintenance so that the economical and efficient practices are developed.

III. to acquire and report maintenance cost data so that the unit cost for specific sections may be determined

2.2.5 Road Maintenance at Design stage

According to Reginald (1987), it is important to view maintenance in the context of the overall construction process. The role played by maintenance in the construction process can start from design stage. The involvement of maintenance department in this stage is as an advisor to the designer to figure out the maintenance problem in the future. Regarding to Armstrong (1984), some of the advantages of the involvement of maintenance department in early stage is to be able to check the practicability of the design details, the suitability of the structures that can prevent further defects in the future caused by inappropriate design.

P.Orr (2006), stated that the first step in design is selecting the correct repair to fix the problem. In too many cases, the choice of repair is made for non- technical reasons. In addition, many maintenance repairs are made without any design. Knowing what needs to be done to get the right repair is one of the most critical steps in the design of pavement maintenance.

According Derek *et al.* (1986), it is uncommon for both the designer and the owner to give emphasis to maintenance at the design stage. He further stressed that the main problem of maintenance stars at design stage.

2.2.6 Road Maintenance Activities

Paterson (1987), stated that road maintenance activities can be subdivided into three main categories, namely routine works, periodic works, and emergency works.

2.2.6.1 Routine Maintenance

Routine maintenance operations are those that may be predicted and planned in advance. These operations, which may be preventive or corrective in nature, are conducted on a regularly scheduled basis using standard procedures. Proper scheduling of these operations is utilized to provide minimum disruptions and hazards to the driving public (Travis, 2013).

Regarding to John (2006), Routine maintenances are all maintenance activities that have to be carried out at least once per year, if not more frequent. Such activities include inspections, cleaning of drains, controlling of vegetations, filling of potholes and ruts, etc.

According to World Road Association (WRA) (1994), routine maintenance 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 regarding every six months.

Routine maintenance works are works that are undertaken each year and funded from the recurrent budget. Activities are grouped into cyclic and reactive work types. Cyclic works are

those undertaken where the maintenance standard indicates the frequency at which activities should be undertaken. Examples are verge cutting and culvert cleaning, both of which are dependent on environmental effects rather than on traffic levels. Reactive works are those where intervention levels, defined in the maintenance standards, are used to determine when maintenance is needed. An example is patching, which is carried out in response to the appearance of cracks or potholes (World Bank, 1994).

Routine maintenance remains as the key activity as it is the least costly activity, which provides the greatest benefits. Some of the most common types of routine works are road patching, sealing of surface cracks, edge repairs, treatment for rutting and pavement repairs, re-grading of road shoulder, grass cutting, maintenance of road furniture, maintenance of bridges and culverts, cleaning of drains, landscaping, and routine inspection.

2.2.6.2 Periodic Maintenance

According to Operational Guidance Transport Note No.TRN-4: World Bank (2005), periodic maintenance 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. According to the operational guidance presented by World Bank, a paved road repaving is needed about every eight years; for gravel road re-graveling is needed about every three years. Periodic maintenance is required at periods of several years where frequency depends on the damaging factor as well as the standard of maintenance.

According to John (2006) all repairs that carried out at a regular interval are considered to periodic maintenance. Periodic maintenance includes all sorts of repairs including resurfacing, overlays, and reconstruction of pavement, base and even sub base course. Periodic maintenance is an activity that is undertaken approximately every 3-5 years and is concerned with rectifying defects that are outside the scope of routine maintenance. The key reason of periodic maintenance is to preserve the structural integrity of the road, or to enable the road to carry

increased axle loadings. The category normally excludes those works that change the geometry of a road by widening or realignment.

2.2.6.3 Emergency Maintenance

Regarding to John (2006) Emergency repairs are all maintenance activities that have to be carried out immediately to safe lives or prevent disastrous consequences of damaged infrastructure. Typical examples of such emergencies are structural damages to fly overs due to accidents. Maintenance departments need unrestricted access to emergency maintenance budgets that allow them to carry out repairs that mitigate immediate dangers. Some senior management may wish to control access to emergency repairs for works with more long-term focus.

2.2.7 Construction and Maintenance

The preoccupation of road professionals in the past has been mostly with road construction. However, as road networks around the world are substantially completed and as existing network age, the emphasis work is now changing away from construction towards maintenance (Robinson *et al.,* 1998). Compared with construction the problem of managing road maintenance has proved to be particularly difficult issue for many countries (Schlissier and Bull: World Bank, 1998). Maintenance is an ongoing activity with a start or end. It is a process rather than a project. Table 2.1 below shows the difference between maintenance and project.

Table 2.1: Some differences of construction and maintenance

Item	**Construction**	**Maintenance**
Nature of Activity	Project	Process
Duration	Tend to be short term	Ongoing-long term
Location	Relatively constrained	Normally wide spread
Cost per kilometer	Relatively high	Relatively low
Principal skill required	Engineering, Project Management	Engineering, Business Management

Source: (Robinson *et al.,* 1998)

2.2.8 Levels of Maintenance and Rehabilitation

Many agencies have developed and used their own strategies for maintaining the condition of their roadway networks. These strategies may vary from maintenance to reconstruction action depending on the extent of the observed deficiencies, execution time, and the expected future performance of the pavement (Chairul, 1991). According to FHWA (1987), the strategies used at different pavement condition levels can generally be classified into four categories. Detailed descriptions of these classifications, drawn from the FHWA Pavement Rehabilitation Guide are given below:

1. ***Restoration*** - includes work required to return the existing pavement structure to a suitable condition to perform satisfactorily for period of time or prepare it for an overlay.

2***. Resurfacing*** - is the placement of an asphalt layer over an existing pavement surface. It is the most popular method of rehabilitation for existing pavements. This is probably because it can be used to correct several surface deficiencies and also to increase the structural capacity of a pavement.

3. ***Recycling*** - is the process of utilizing materials in an existing pavement in the rehabilitation of that pavement.

4. ***Reconstruction***- is construction on the existing pavement section where the entire existing pavement structure is removed and replaced.

2.2.9 Timely Maintenance

Carrying out timely maintenance on a road in good condition will extend the life of a pavement, as illustrated in Figure 2.2 below. On the other hand, delays in executing maintenance generally leads to increased severity of deficiencies (i.e., to poor or very poor conditions) and can eventually lead to a need for complete pavement rehabilitation or reconstruction in later years. This can increase the life cycle costs associated with a particular pavement section (Chairul, 1991).

Besides the timing of maintenance execution, Chairul (1991) stated that the strategy used to

correct a deficiency can also have a significant effect on the performance of a pavement. The choice of strategy is also an important parameter in determining the long-term performance of a pavement.

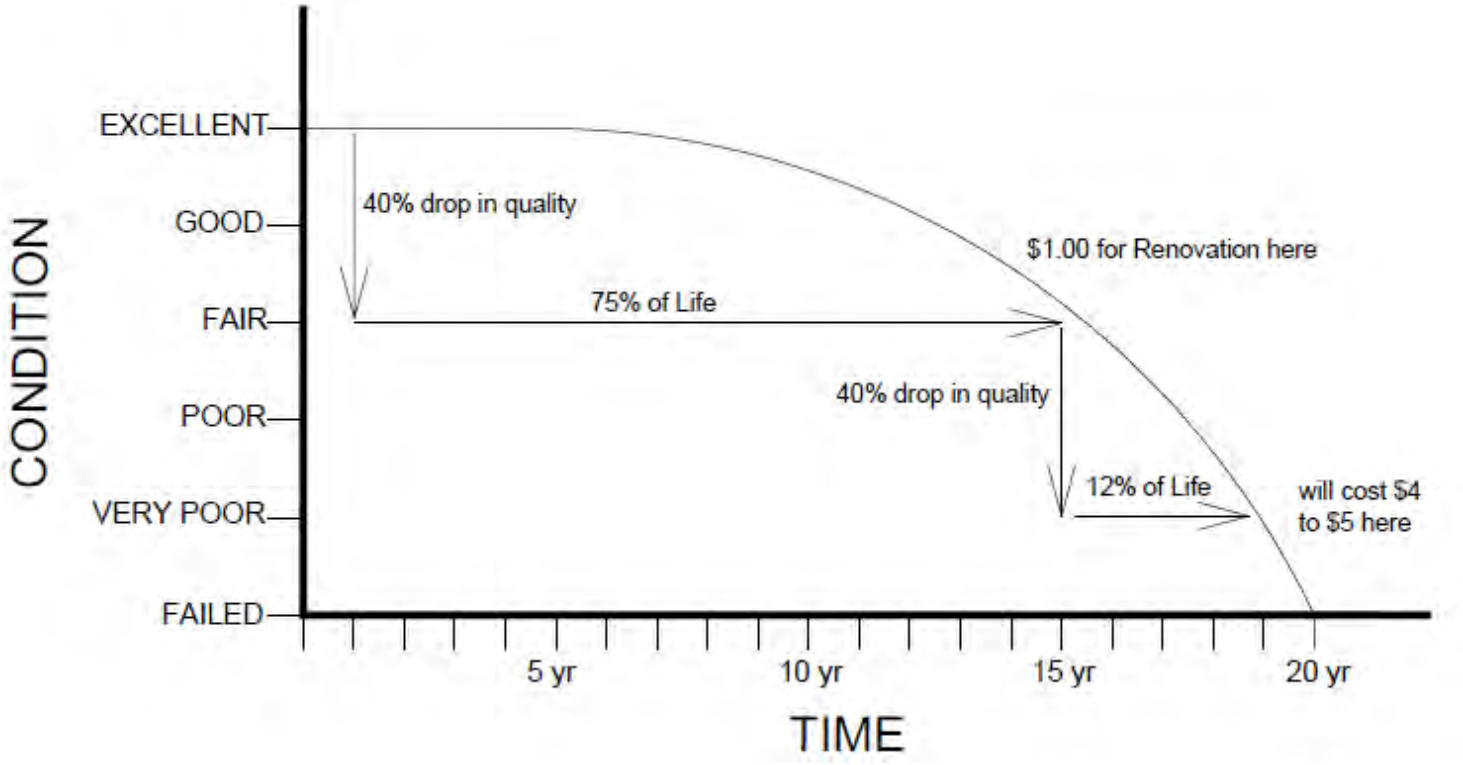


Figure 2.2: Illustration of Pavement Life Cycle

Source: (Chairul, 1991)

2.2.10 Effects of Neglecting Road Maintenance

An area of major concern for most highway agencies today is the maintenance of deteriorating pavements. According to a World Bank report (World Bank, 1988) the developing countries have lost precious infrastructure worth billions of dollars through the deterioration of roads. The cost of restoring these roads is going to be three to five times greater than the bill would have been for timely and effective maintenance. Vehicle operation costs rapidly outpace the costs of road repair as the condition of road passes from good to fair to poor'. In developing countries, the problem of highway pavement maintenance is of immense significance due to high traffic growth and inadequate funding. In India, (2003) it is estimated that an amount of $ 20 Billion was spent by road users on vehicle operation cost. The loss due to poor road condition is assessed to be around $ 4 Billion per annum.

Levik (2003), in his work „Road Maintenance is Necessary" described the effect of neglecting road maintenance by raising different cases all over the world.

In Oslo, Norway a bridge deck did not have adequate waterproof membrane. It could have been done as a simple job for a cost of approximately 0.6 million US dollars. The job was not given preference and was therefore not done. The result was that after some years the whole bridge had to be torn down and replaced by a new bridge. The total cost for the new bridge was 15 million US dollars. There was an additional cost to the users, because they had to travel on lengthy detours for a long period of time.

In Kenya, years of inadequate maintenance left the main Nairobi-Mombasa road highly vulnerable. In 1997, heavy rain damaged two bridges and several sections of the road. The result was that the national users experienced months of disruptions as long stretches of the road became unusable in the rains and very difficult in dry weather.

In Tanzania, failure to improve a simple stream crossing caused damage to 3 kilometers of road and led to lengthy delays. The result was a bill five times higher than would have been needed to make the original repair.

In Sub-Saharan Africa 150 billion US dollars was spent in 3 decades building roads. Maintenance was neglected and a third of that investment has now been lost. The result is that 50 billion US dollars of key national assets are gone.

A recent analysis of how 85 countries allocated road maintenance funds showed that, spending 12 billion US dollars on preventive maintenance would have eliminated reconstruction costs of 40 billion US dollars. The result is that an average net cost of 330 million US dollars, are wasted on avoidable reconstruction in each country.

A new road is expensive. In Norway a two-lane paved new road costs about 0.5million US dollars per Km on average. Routine maintenance of this road costs about8, 000 US dollars per year per Km. If maintenance is neglected, it will cost five or six times as much to restore the road. It is an indefensible waste economically.

If money is short, and it usually is, there is only one rational course of action maintain existing roads before funding new ones; make sure it is done today, and every day. Tomorrow it might be much more expensive.

It is often forgotten that building of roads is only a part of the total transport cost. While this total cost includes maintenance and building costs, it also includes the full cost of running vehicles on a road, an expense that rapidly increases as the surface starts to deteriorate. It is essential to take the total transport cost into account when making decisions concerning your roads. You have to have a policy that reflects the economic realities.

2.2.11 Impact of Poor Road Maintenance Practice

Based on the study made by World Bank (2007), most roads in Africa are poorly managed and badly maintained and almost without exception, the roads are managed by bureaucratic government road departments. The study further reveled that it would take nearly $43 billion to fully restore all roads classified as being in poor condition (i.e., requiring immediate rehabilitation or reconstruction). In other words, African countries have spent far too little on routine and periodic maintenance during the past twenty years. As a result, nearly a third of the $150 billion invested in roads has been eroded through lack of maintenance. Africa has been living off its assets. Restoring only those roads that are economically justified and preventing further deterioration will require additional annual expenditures over the next ten years of at least $1.5 billion. This amounts to nearly one percent of regional GDP and would increase current road spending from one percent to nearly two percent of regional GDP. The remaining roads in poor condition will have to receive minimal maintenance or be handed over to lower levels of government and local communities (Heggie: World Bank 2007).

According to Heggie (2007), the economic costs of poor road maintenance are borne primarily by road users. In rural areas, where roads often become impassable during the rainy season, poor road maintenance also has a profound effect on agricultural output. When a road is not maintained and is allowed to deteriorate from good to poor condition each dollar saved on road maintenance increases VOCs by$2 to $3. Far from saving money, cutting back on road maintenance increases the costs of road transport and raises the net cost to the economy as a whole.

It is estimated that the extra costs of insufficient maintenance in Africa amount to about $1.2 billion per year, or 0.85 percent of regional GDP. About 75 percent of these costs must be paid with scarce foreign exchange. During preparation of the Integrated Roads Project in Tanzania, it was estimated that the annual economic costs of poor road maintenance were between $100 and $150 million. Likewise, during an RMI workshop in Kenya, it was estimated that the $40 million annual shortfall in road maintenance expenditure increased VOCs by about $150 million per year. In general, road maintenance and rehabilitation projects produce economic rates of return of over 35 percent.

Poor road maintenance also raises the *long-term costs* of maintaining the road network as maintaining a paved road for fifteen years costs about $ 60,000 per km. If the road is not maintained and allowed to deteriorate over the fifteen-year period, it will then cost about $ 200,000 per km to rehabilitate it. In other words, rehabilitating paved roads every ten to twenty years is more than three times as expensive, in cash terms, as maintaining them on a regular basis, and 35 percent more expensive in terms of NPVs discounted at 12 percent per year.

The same is true of gravel roads maintaining a gravel road for ten years costs between$10,000 and $ 20,000 per km, depending on climate and traffic volumes. On the other hand, leaving it without maintenance for ten years will require rehabilitation costing about $ 40,000 per km. Rehabilitating gravel roads every ten years is thus twice as expensive, in cash terms, as regular routine and periodic maintenance, and between 14 and 128 percent more expensive in terms of NPVs discounted at 12 percent per year **(**Heggie: World Bank, 2007).

Heggie (2007), identified two factors that have contributed to the above shortsighted policies. First, lack of market discipline has encouraged governments to minimize their own (road maintenance) expenditures, disregarding the impact that this has on total road transport costs (road maintenance costs plus VOCs). Second, maintenance is normally financed under the recurrent budget, and recurrent revenues are nearly always in short supply. Since donors have been willing in the past to finance rehabilitation under the development budget (often on a grant basis), governments had every incentive to capitalize road maintenance and charge it against the development budget. Rehabilitation, rather than recurrent maintenance, became the optimal solution.

Donors quickly recognized this mistake, and most will no longer finance rehabilitation programs until sustainable road maintenance policies have been introduced.

As mentioned earlier, the extra cost of insufficient maintenance in Africa amounts to $1.2 billion per year. In developing countries like Latin America and Caribbean equivalent figures were estimated at $1.7 billion per year (Heggie and Vickers, 1998).

Heggie and Vickers (1998), citing Indian Ministry of Surface Transport (1998), stated that $4 billion of the roughly $39 billion in annual VOCs could be saved by proper maintenance. Moreover, a study made on Republic of Kazakhstan analyzed how the absence of periodic maintenance due to insufficient fund affected the national road network. The analysis demonstrated that if the periodic maintenance was deferred for years on 7500 Km of roads, the government would save $180 million per year in maintenance costs.

In Latin America a rough estimate made in 1992 showed that it would cost about $22.5 billion per year for a decade to remove the backlog and prevent further accumulation of deferred maintenance. The estimated backlog of maintenance in Kazakhstan was $1.8 billion while that in Russia for federal highway network alone is $4.5 billion per year over unspecified period (Heggie and Vickers, 1998).

Based on the study of Heggie and Vickers (1998), attempts to improve road financing concentrated on increasing allocations for maintenance in Africa and Latin America, earmarking funds to secure a stable flow. Donor countries often asked governments to set aside part of their general tax revenue (usually specified as percentage of overall fuel tax revenue), deposits the money into a road fund and use the proceeds to finance maintenance of core road network. But apart from pointing out the economic costs of deferred maintenance and suggesting that funds be reallocated from construction to maintenance, little advice was offered on where the addition revenues might come from and how the road fund should function.

The study summarized that it will be almost impossible to overcome the numerous technical, organizational and human resource problems that hampers sound road maintenance policies, with weak road maintenance institutional arrangement for managing and financing of road networks.

2.3 Road Maintenance Contracts

According to Segal *et al*. (2003) there are two main types of contracts that public officials choose from when contracting for road maintenance, these are Traditional and performance based contracts, in which the later will be discussed further.

2.3.1 Performance Based Road Maintenance Contracts

According to National Cooperative Highway Research Program (NCHRP) (2009) performance based maintenance contracts is an approach to contracting that provides disincentives, incentives, or both to the contractor to achieve performance standards or targets for measurable outcomes and sometimes outputs.

The NCHRP further stressed that the disincentives or incentives can consist of reductions or increases in payments for respectively falling short or exceeding the desired targets. Some disincentives or incentives are not directly tied to measurable outcomes and outputs. These disincentives or incentives include liquidated damages for failing to satisfy a contract provision, an award fee for satisfying qualitative criteria, and a contract extension if the contractor performs well. Performance-based contracts (PBC) differ significantly from traditional method-based contracts that have been traditionally used to maintain roads. PBMC is a type of contract in which payments for the management and maintenance of road assets are explicitly linked to the contractor successfully meeting or exceeding certain clearly defined minimum performance indicators **(**World Bank, 2005).

According to the World Bank Procurement Guidelines (2004), performance-based procurement, also called output-based procurement, refers to competitive procurement processes resulting in a contractual relationship where payments are made for measured outputs instead of the traditional way where the measurement and payment reflects the quantity of input. For example, the contractor is not paid for the number of potholes he has patched, but for the output of his work: no pothole remaining open (or 100% patched). Failure to comply with the performance indicators or to promptly rectify revealed deficiencies adversely affects the contractor's payment through a series of clearly defined penalties. In case of compliance the payment is regularly made, usually in equal monthly installments.

PBC within the road sector can be "pure" or "hybrid". The latter combine features of both method- and performance-based contracts. Some services are paid on a unit rate basis, while others are linked to meeting performance indicators (World Bank, 2005).

2.3.2 History of Performance Based Road Maintenance contract

The first PBMC of road maintenance was piloted in British Columbia, Canada, in 1988 (Zietlow, 2004). Later, PBMCs were introduced and adopted in two other Canadian provinces: Alberto and Ontario.

In 1995 Australia launched its first PBMC to maintain urban roads in Sydney. Since then New South Wales, Tasmania, and Southern and Western Australia have started using performance-based and "hybrid" approaches (Zietlow, 2004). In 1998, PBMC was introduced in New Zealand to maintain 405 km of national roads (Zietlow, 2004). PBMCS was first introduced in the USA in Virginia State in 1996. Since then, four other states (Alaska, Florida, Oklahoma, and Texas) and Washington DC have started applying a PBMC approach to maintain highways, bridges, tunnels, rest areas and urban streets (FHWA, 2005).

In the developing world Latin America was the pioneer in developing and adopting its own performance based contracting model. In 1995, Argentina introduced performance-based contracts, which at present cover 44% of its national network (Liautaud, 2004). In the mid nineties Uruguay also piloted PBMCS, first on a small portion of its national network and then on the main urban roads of Montevideo. Shortly thereafter, other Latin American countries, such as Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico and Peru, also started adopting a performance-based approach.

Gradually, this trend has spread to other developed and developing countries in Europe, Africa and Asia, e.g., UK, Sweden, Finland, Netherlands, Norway, France, Estonia (63% of national roads), Serbia and Montenegro (8% of national roads), South Africa (100% of national roads), Zambia, Chad (17% of all season roads), the Philippines (231 km of national roads). At present, preparations for launching PBC programs are underway in Albania, Cape Verde, Chad, Madagascar, Tanzania, Burkina Faso, India, Cambodia, Thailand, Indonesia, Vietnam and

Yemen (World Bank, 2005). Some of the above countries use "pure" performance-based contract while others (e.g., Finland, South Africa, Serbia and Montenegro) use "hybrid" contracts.

2.3.3 Advantages of performance Based Road Maintenance Contracts

According to World Bank (2005), Road agencies that have adopted a PBMC approach have achieved:

***I. Cost savings from 10% up to 40%*:** For example, the USA Virginia Department of Transportation pays USD 22,400 per mile per year under PBC, while in-house maintenance costs USD 29,500 per mile per year In New Zealand, there has been a 30% decrease in professional costs and 17% decrease in physical works with traffic growth by 53% (FHWA, 2005). In addition, evaluations made by Liautaud (2005), indicate that the savings in costs accrued from the PBC are in order of 12 to 18% compared to the traditional method-based contracts. Cost comparisons are not readily available for other developing countries that have adopted a PBC approach (Table 2.2).

Table 2.2: Cost savings of different countries under PBC over the conventional contracts

Country	**Cost saving per cent (%)**
Norway	About 20-40%
Sweden	About 30%
Finland	About 30-35%; about 50% less cost/km
Holland	About 30-40%
Estonia	20-40%
England	10% minimum
Australia	10-40%
New Zealand	About 20-30%
USA	10-15%
Ontario, Canada	About 10%
Alberta, Canada	About 20%
British Columbia, Canada	Some, but might be in the order of 10%

Source: (Pakkala, 2005)

II. Expenditure certainty: As the contractor is paid a fixed price, based on a regular schedule the road agency enjoys full control of expenditures without unexpected variation orders.

III. Improved conditions of contracted road assets and reduction of roads in poor condition: Many road agencies have acknowledged that on completion of a PBMC, road assets are generally returned either in an improved condition or in a condition similar to when the PBC was awarded, but not in a worse condition. The Department of Transportation in Texas State, USA, has reported "after the first year of the performance-based contracts, [road] facilities were rated at an average of 91%, an 18-point increase over their pre-contract condition" (FHWA, 2005). Argentina has reduced the share of roads in poor condition from 25 percent to less than 5 percent by the end of 1999 due to the PBMC approach (Liautaud, 2004).

IV. Greater road user satisfaction: Road users appear to become more satisfied with the services delivered and the condition of the roads maintained under PBMCs. No quantified results of improved road user satisfaction, reflecting PBMC implementation have been reported to date, some agencies have noticed a decline in the number of complaints from road users. For example, in Chad "road users appreciate that the road is always in good conditions and not only after specific works were completed. Especially important is that they can use the road in the rainy season, which was impossible before" (Zietlow, 2004).

V. Multi-year financing of a maintenance program: For example, by making the long-term payment obligations legally binding on the government, the CREMA contracts in Argentina have deterred the Treasury from failing to provide funding for road maintenance (Liautaud, 2004). The growth and expansion of a PBC approach to other roads in the network is the best indicator of its success. The Department of Transportation in Washington DC, USA, recognizes PBC as an effective way to keep assets at or above their current condition. It has therefore decided to apply this approach for management and maintenance of tunnels, street lighting, and other streets in Washington DC.

2.3.4 Reasons for Doing Performance-Based Road Maintenance Contracting

NCHRP (2009), citing (Hardy 2001; Pakkala 2002; Stankevich *et al.*, 2005) stated that an agency might decide to do PBMC or expand the amount of this type of contracting for numerous reasons. Following are commonly cited motivations:

- Potential to reduce agency costs

- Change in performance criteria from a focus on inputs and outputs to customer-oriented outcomes
- Response to a mandate of the executive branch or legislature to outsource more maintenance work or do PBMC.
- Pressures on the operating expenditures budget
- Need to do more with less as a result of growing maintenance needs in the face of a downsized or fixed maintenance work force
- Ability to achieve expenditure stability fixed costs because PBMC often involves long-term, lump sum contracts with fairly predictable payments to contractors
- A more defensible way to secure maintenance dollars within the agency and from the legislature when there is receptivity to using performance-based methods of contract management
- Means to achieve a fixed level of service, assuming, over time a contractor can meet performance target sand then maintain constant Level of Service (LOS).
- Shifting risks to or sharing risks with contractors
- Potential to realize significant benefits from effective partnering between the agency and the contractor
- Ability to encourage the contractor to minimize life cycle costs assuming the contract term is long enough
- Fostering more innovation by allowing the contractor the freedom to use any method to meet performance specifications rather than have to adhere to method specifications (innovations may pertain to equipment, materials, computer systems and applications, communications, work methods, partnering, and business practices)

According to Zietlow (2004) the main reasons for implementing performance based contract are to:

- reduce maintenance costs through the application of more effective and efficient technologies and work procedures;
- provide transparency for road users, road administrations and contractors with regard to the conditions roads have to be maintained;

- Improved control and enforcement of quality standards; and
- Improved overall road conditions.

According to AASHTO (2002), foreign countries have a number of additional compelling reasons to use PBMC. Developing countries cannot afford to let their highway systems deteriorate to the point at which they must be reconstructed. Reconstruction is very expensive compared with timely maintenance and diverts limited funds from transportation or other sectors where money is badly needed.

2.3.5 Impediments to Performance-Based Maintenance Contracting

According to NCHRP (2009), citing (Pakkala 2002; Ribreau 2004; Hill *et al.*, 2007; Science Applications International Corporation 2007; survey responses; and panel member input) the following are some of the reasons for not taking performance based road maintenance contracts.

- Lack of government support (legislative or executive branch)
- A significant change in culture required by the contracting agency and contractors not familiar with this approach
- Adjustments required going from method to performance specifications
- Inadequate experience with PBMC or a negative experience on the first try
- Lack of training
- Lack of legal authority
- Challenges in estimating in-house and contractor costs
- Loss of quality sometimes observed in the first years of a long-term contract
- Insufficient contractor capacity
- Inability to achieve sufficient competition
- Potential bonding or warranty requirements, including those established by state law
- Incomplete or inaccurate asset inventory and condition data
- Concern over loss of control over methods, equipment, and material used
- Concern that life-cycle costs will increase
- Fear that privatization will result in large numbers of staff having to leave government

2.3.6 Basic Steps of Performance-Based Maintenance Contracting

According to Zietlow (2004), the approach taken to implement Performance Contracts varies from country to country. According to NCHRP (2009), the following steps can be taken as a guide line for implementation of performance based road maintenance contracts.

- Geographic areas, and portions of the roadway network that would benefit from PBMC;
- Decide on the types of maintenance and area/roads that will be the focus of the contract;
- Complete an inventory of assets;
- Assess inventory condition;
- Bring items up to par or make this a contract or requirement;
- Determine the scope of services;
- Define the LOS (condition) to be achieved;
- Define qualifications of prime and subcontractors;
- Set term of contract;
- Address record keeping;
- Define owner responsibilities;
- Define contractor insurance requirements;
- Determine bonding requirements;
- Establish payment criteria including incentives and disincentives;
- Develop approach of performing inspections;
- Draft Request for Proposals (RFPs);
- Establish monthly payment with adjustments for performance incentives and disincentives;
- Hold pre bid meeting;
- Finalize and issue RFP;
- Make award;
- Conduct meeting with contractor before start of work;
- Authorize work to begin;
- Allow contractor to perform work;
- Conduct periodic and random inspections of performance;

- Make monthly payments to the contractor in accordance with performance; and
- End contract, unless it is renewed for a subsequent term.

But, Zietlow (2004) argues that before the implementation of PBMC it is important to analyze the countries legal and financial feasibility first. One of the most important legal aspects is the maximum contract period allowed by law. In most of the countries in Latin America, for example, the maximum contact duration is restricted to either four or five years, making it necessary to change laws in order to accommodate long-term contracts. Financing has to be secured for the entire duration of the contract.

2.3.7 Acquisition Process for PBMC

According to NCHRP (2009), obtaining qualified contractors to perform under a performance-based maintenance contract requires the contracting agency to have an appropriate selection process. The contracting agency must perform due diligence to ensure that the winning contractor is able to achieve the desired performance standards.

An agency cannot start too early in identifying potential contractors. The ways to do so include (1) identifying contractors that have performed similar work for other government agencies, (2) issuing a Request for Qualifications (RFQ), (3) inviting contractors to an information meeting or a pre bid conference designed to encourage contractors to form teams, and (4) examining the feasibility of restructuring the government maintenance organization into a part that will administer the contract and another part that will compete for the work (Pakkala, 2002; Hyman 2003).

In a number of countries, governments will contract with a consultant or the equivalent of a system manager who in turn will oversee the activities of the contractor that will enter the performance based maintenance contract (Pakkala, 2002).

2.3.8 Types of Performance-Based Contracts

According to NCHRP (2009), citing AASHTO (2002), there are a handful of different types of performance-based contracts. These are:

- **Single activity.** A simple performance-based contract may deal with only a single activity such as sign replacement or striping.
- **Single asset.** A performance-based contract may pertain to just one type of asset, but it could involve a single maintenance activity or multiple activities. A performance-base contract for bridge maintenance is likely to involve numerous bridge maintenance activities such as joint repair bearing replacement, and washing and cleaning.
- **Set of related activities.** Sometimes a performance based contract pertains to a set of activities that are related by virtue of their location, the type of asset they concern, or other factors. A good example is a contract that concerns rest area maintenance.
- **Corridor.** Many performance-based contracts pertain to corridors, often long sections of limited access highways. These contracts are likely to address all activities necessary to maintain the assets in the corridor and ensure safe and efficient highway operations. These contracts frequently concern everything in the right-of-way and are sometimes called fence-to-fence maintenance contracts.
- **Area wide.** A performance-based contract can concern areas of different size. A garage or area shop might have a performance contract that pertains to its area. An area wide PBMC could also concern a district, city, town ship, county, state, or country. An area wide contract could cover one activity or all types of maintenance activities and assets within the relevant boundary.
- **Hybrid.** There are a variety of different hybrid contracts. One has a combination of method specifications and performance specifications. Another has incentives and disincentives that are both output- and outcome-driven. A third uses a combination of unit prices and a lump-sum payment, where the latter is adjusted based on whether or not the contractor meets performance standards.
- **Agency-to-agency.** A public agency responsible for maintaining a roadway network contracts with one or more other public agencies to perform the maintenance. States may contract with counties to perform maintenance, as in Wisconsin. Many Michigan counties contract with the state for maintenance. States may also contract with cities or authorities for maintenance services under certain circumstances.
- **Warranty-based.** These are contracts that require the contractor to warranty the workmanship and materials for one or more maintenance activities. Warranties require

the contractor to maintain the end product in the condition specified for a certain number of years. Warranties can apply to pavements, rest areas, signs, striping, and so on. If the contractor fails to meet the terms of the warranty, then the contractor must fix the problem.

2.3.9 Basic Categories of Measures

According to NCHRP (2009), citing (Hatry, Fountain, Sullivan, and Kremer 1990; Government Performance and Results Act 2003; Hyman 2004). PBMC requires a clear understanding of the fundamental types of measures the basic categories of measures are as follows:

I. **Inputs:** These are resources applied to maintenance. They usually consist of labor, equipment, materials, and the associated financial expenditures. In some instances, resources can include other things; for example, facilities or land.

II. **Outputs:** These are accomplishments or, in other words, how much work gets done. Traditional maintenance management systems record accomplishments (outputs) and resources used (inputs) upon completion of work. Some performance-based contracts specify the outputs to be achieved. Examples of outputs include lane-miles of bituminous resurfacing or linear feet of guardrail replaced. The amount of work done is a reflection of the efficiency and effectiveness of the organization performing the maintenance.

III. **Outcomes:** These are the results or changes that occur as a result of maintenance. To an increasing degree, PBMC is concerned with outcomes that are important to customers of roads. Depending on the type of maintenance being performed, customers can be viewed as road users, those who pay for the roads, and owners of property adjacent to roads that experience spillover effects such as the spread of invasive plants from the right-of-way. Examples of customer oriented outcomes are as follows smoothness of pavements; visibility of signs and markings at night; cleanliness of rest areas; traffic signals quickly restored to operating condition after they stopped working properly (i.e., response times are frequently a part of performance based maintenance contracts).

IV. Explanatory Variables: It is desirable for the contracting agency and contractor to keep track of variables that can help explain resource utilization, outputs, and outcomes. Many explanatory variables are outside the control of the contractor and agency and include traffic growth, weather, emergencies, and terrain. Accounting for explanatory variables outside the contractor‟s control provides a basis for adjusting incentives and disincentives and more fairly allocating risk.

2.3.10 Contractor Selection Criteria for PBMC

According to NCHRP (2009), Contractor selection criteria include low bid, modified low bid, best value, Qualifications-Based Selection (QBS), and technical submittal and negotiation. Low bid may be elective or a legal requirement. Modified low bid introduces non-price considerations by weeding out potential bidders that cannot satisfy minimum qualifications. Using a pre- or post bid qualification process can accomplish modified low bid. The contracting agency picks the contractor offering the lowest bid from the set of pre- or post qualified bidders (Science Applications International Corporation, 2007).

Selecting a contractor based on best value involves giving a certain percentage weight to technical considerations and the remainder to costs. Table 2.3 shows representative weights used in different countries from around the world. Many different criteria may be used to determine the technical score, such as the following:

Table 2. 3: Contractor selection criteria for different countries.

Country	**Weights for Selection Criteria**
Australia (Sydney, WA, Tasmania)	50% price; 50% other, varies with Territory
Canada (Alberta, British Columbia, Ontario)	78% price, 22% other; 40% price, 60% other; and 90% price; 10% other;
England	30%–40% price; 60%–70% other
Finland	75% price; 25% other
New Zealand	50% price; 50% technical criteria
Sweden	90% price; 10% other

Source: [Pakkala (2002) cited in Stankevich (2005)].

2.3.11 Monitoring and Evaluation of Contractor

There are a variety of approaches to monitoring and evaluating the contractor. The first approach allows the contractor to monitor it through frequent and periodic reporting. The contracting agency normally would require the contractor to submit monthly and annual reports on service levels being achieved. The agency will have to be certain that the evaluation is performed properly by joining the contractor when it collects data, conducting random inspections, insisting that the contractor execute a sound QC plan, and ensuring that the contractor provides documentation suitable for making payment determinations. Once the agency is confident that the contractor is providing accurate information, the agency does not have to undertake as much oversight. The big advantage of this approach is that it is less costly than other approaches and the agency communicates that it trusts the contractor; partnering is strengthened. Many would say the evaluation responsibility should not be placed on the contractor, however, because the risk of inaccurate reporting increases (NCHRP, 2009).

In the second approach, the agency has primary responsibility for determining the performance of the contractor. A disciplined approach is essential, typically Maintenance Quality Assurance (MQA) process. In addition to periodic inspections, the agency might use random, unannounced inspections. If the agency conducts the evaluations with the contractor present, it promotes good communication and understanding. If the agency conducts the evaluation without the contractor present, the arm‟s-length approach will reduce the strength of the partnering relationship (NCHRP, 2009).

The third approach is to use an independent third party to conduct contractor evaluations; a method that provides the most objectivity. It also leaves room for the agency and the contractor to develop a strong partnering relationship, because the burden of evaluation lies on the independent third party. There will be an added cost of an independent evaluator, but it is likely to lead to monetary and nonmonetary benefits (Science Applications International Corporation, 2007).

2.3.12 Allocation of Risks

According to NCHRP (2009), another primary motivation for transportation agencies to adopt PBMC is to shift a significant portion of risk to the contractor. Maintenance contracting has the following types of risks, among others:

- Poor quality of construction
- Unexpectedly severe weather
- Unanticipated environmental problems
- Emergencies
- Unanticipated legislative change
- Unexpected traffic growth
- A short-term focus that fails to minimize long-term life-cycle costs
- Difficulty in acquiring the resources needed to perform the work (e.g., subcontractors)
- The possibility of having to correct problems covered under a warranty.

Certain types of performance-based maintenance contracts place an upper limit on a transportation agency‟s payments to the contractor. Lump-sum contracts with deductions for failing to meet performance targets are used around the world, although contracts that also have positive financial incentives may produce better outcomes. Furthermore, by lengthening the period of performance of a PBMC, the agency can reduce the risk that a contractor will ignore long-term goals, such as minimizing life-cycle costs, when it makes short-term decisions. With long-term contracts, the contractor is also better able to amortize facility and equipment costs. Using a prequalification process further minimizes the risk to the contracting agency (NCHRP, 2009). PBMC is a two-way street, a partnership. If an agency goes too far in trying to shift risks to contractors, there can be a negative effect. For example, if an agency forces a contractor to bear all the risks of severe weather in a hurricane prone state, the contractor may raise its price to perform the work, refuse to work in an area, or go out of business.

2.3.13 Methods for Inspection of Service Quality Levels of Pavements

According to World Bank (2002), the following are the different types of inspections for pavements service quality measures.

2.3.13.1 Formal Inspections of Service Quality Levels

Formal inspections are those which are scheduled in advance by the Project Manager (who is responsible for the overall administration of the contract on behalf of the employer), and carried out by the contractor (through his self-control Unit) under the supervision of the project manager. The main purpose of the formal inspections is to enable the project manager to verify the information presented in the contractor‟s monthly statement and to issue the Interim payment certificate. The project manager must inform the contractor of his intention to carry out a formal inspection at least 48 hours in advance, indicating the exact date, hour and location where the formal inspection is to begin. The contractor is obliged to be present at the date, hour and location specified by the project manager, providing the physical means of inspection as indicated further below. Formal inspections will normally, but not necessarily are scheduled to begin within less than five (5) days after the presentation by the contractor of the monthly statement to the project manager; and they should normally be completed within a maximum of five (5) days (World Bank, 2002).

The formal inspection allows comparing the information on compliance provided by the contractor in the standard tables which are part of his monthly statement, with actual measurements taken in locations to be determined by the project manager. During the formal inspection, the project manager will prepare a brief memorandum describing (i) the general circumstances of the site visit, including date, road sections visited, persons present etc., (ii) the nature and location of any non-compliance which may have been detected, and (iii) the time granted by the project manager to the contractor to remedy the detected defects. Based on the outcome of the formal inspection, the project manager will immediately correct any possible errors or misrepresentations in the contractor‟s monthly statement, countersign it and present it to the employer for payment, and to the contractor for information. It will also be scheduled for the follow-up site visits, whose purpose is to verify if the contractor has remedied the causes of earlier non-compliance, within the time frame granted by the project manager and specified in the memorandum. During the course of the regular monthly inspections, the project manager may however increase the total length of the road sections tested, in particular if numerous cases of non-compliance are detected (World Bank, 2002).

2.3.13.2 Informal Inspections of Service Quality Levels

According to World Bank (2002), the project manager may carry out informal inspections of service quality levels as part of the general mandate given to him by the Employer. He may do so on his own initiative, at anytime and anywhere on the roads included in the contract. He must use his own means for those inspections. If he detects any road sections where the service quality criteria are not met, he is obliged to inform the contractor within 24 hours in writing, in order to enable him to take remedial action as soon as possible. The results of informal inspections may not be used by the project manager for purposes of correcting the Contractor‟s monthly statements or applying penalties or liquidated damages, except for cases in which the road has been completely interrupted and the criteria of road usability has not been met.

2.3.14 Performance Level Criteria for Pavements

2.3.14.1 Pavement, Shoulders and Right-of-Way

According to World Bank (2002), the service level criteria for pavements, shoulders and right-of-way are defined as follows:

Table 2.4: Performance service level criteria for pavements

Item	Service quality	Measurement/Detection	Time allowed for repairs or Tolerance permitted
Pavement width	Pavement width must be at least wide as specified in the contract.	Manual measurement using a metallic measuring tape.	No tolerance allowed.
Potholes	No potholes allowed.	Visual inspection.	Potholes must be repaired within three (3) days after their detection.
Patching	Patches (i) shall be square or rectangular, (ii) shall be level with surrounding pavement, (iii) shall be made using materials similar to those used for the surrounding pavement, and (iv) shall not have cracks wider than three (3) mm.	▪ Visual inspection (for detection of shape and material used ▪ Ruler (to check if patch is level with surrounding pavement ▪ Small transparent ruler (for cracks)	Non-complying patches must be repaired within three (3) days after their detection.
Cracking in pavement (a crack is a linear opening in pavement with a width of more than 3 mm.)	There shall not be cracks more than 3 mm wide. For any 50m section of the pavement, the cracked area cannot be more than ten (10) percent of the pavement surface.	Crack widths measured with small transparent ruler. For **isolated cracks**, the "cracked area" includes 0,5 m on each side of the crack, multiplied by the length of the crack plus 0,5 m at each end. For **multiple cracks** and cracks crossing each other, the "cracked area" is equivalent to a square area, parallel to the lanes, which fully encloses the cracks, and where the closest crack is at least 0.25 m away from the sides of the square.	Cracks more than 3 mm wide must be sealed within seven (7) days after their detection.
Cleanliness of the pavement surface and shoulders.	The road surface must always be clean and free of soil, debris, trash and other objects.	Visual inspection	Dirt, debris and obstacles must be removed: within 1 (one) hour if they pose a danger to traffic safety Within 36 hours if they do not pose any danger to traffic safety.
Pavement roughness	Average value for section must be below the threshold value given below (in IRI average) Section 1:……. IRI, Section 2: ……..IRI, Section 3: ……. IRI, Section …..	Measured with calibrated equipment (Bump Integrator).	No tolerance allowed.
Deflection	Average of section must be below the threshold values indicated for each road section.	Measured with Benkelman beam every 50 meters. Threshold value is average for sections of ……meters.	No tolerance allowed.
Rutting	There shall not be ruts deeper than 15 mm. Rutting of more than ten (10) mm shall not be present in more than 5 percent of any of the road sections defined in the contract.	Measured with 2 rulers (horizontal ruler of three 3 m length placed perpendicularly across lane; rut depth measured as space between horizontal	Rutting above threshold value must be eliminated within fifteen (15) days.

		ruler and lowest point of rut, using a small ruler with scale in mm)	
Raveling	Raveled areas must not exist.	Visual inspection.	Raveled areas must be sealed within thirty (30) days after their detection.
Loose Pavement edges (loose)	There shall not be loose pavement edges, or pieces of pavement breaking off at the edges.	Visual inspection	Repairs must be completed within seven (7) days after the detection of the defect.
Height of shoulders vs. height of pavement	Difference in height at edge of pavement shall not be more than 15 mm.	Measured with ruler, with scale in mm.	Repairs must be completed within seven (7) days after the detection of the defect.
Paved shoulders	Must always be sealed to avoid water penetration without deformations and erosions free of potholes and erosions	Visual inspection	Repairs must be completed within seven (7) days after the detection of the defect.
Embankment slopes	Without deformations and erosions.	Visual inspection	Repairs must be completed within seven (7) days after the detection of the defect.
Slopes in cuts	Slopes in cuts must be stable and/or adequate retaining walls and slope stabilization measures must be in place.	Visual inspection for slope material on shoulders or pavement	Fallen slope material must be removed Quantities below 50 m^3: from pavement within 4 hours after detection from shoulders within 48 hours after detection. Between 50 m^3 and 500 m^3 from pavement within 24 hours after detection from shoulders within 96 hours after detection Note: For landslides classified as "emergency" different rules apply.
Trees within right-of-way	Trees within right-of-way must be protected as necessary.	Visual inspection.	None.
Right-of-way (outside pavement and shoulders).	Height of vegetation (except trees) must be less than 20 cm on slopes towards the road less than 1.0 m otherwise must not disturb drainage	Visual inspection. Measurement with ruler.	Vegetation exceeding the threshold height must be cut back within seven (7) days after detection.
	Trash, debris, etc.	Visual inspection.	Trash, debris and other objects must be removed within seven (7) days after detection.
Removal of slides	Slides of slope material onto the road are considered an Emergency if the quantity of the material is above 500 m^3, or if the slide blocks all lanes and the road traffic is completely interrupted, and quantity is above 50 m^3.	If the contractor intends to invoke the contract provisions for emergencies, he estimates the quantities and immediately informs Project Managers, who them verifies.	Traffic flow to be reestablished within a maximum of 6 hours. Period for removal of other slide material is set by Project Manager as specified under provisions for emergencies.

Source: World Bank (2002)

2.3.14.2 Structures

According to World Bank (2002), the service quality level requirements for bridges and similar structures are as shown in the following table.

Table 2.5: Performance service level criteria for Structures

Item	Service quality	Measurement/ Detection	Time allowed for repairs or Tolerance permitted
Steel or other metal structures	Guardrails must be present and painted. All metal parts of overall structure painted and free of corrosion. Drainage system in good condition and fully functional.	Visual inspection	Guardrails damaged by accidents must be replaced within seven (7) days.
Concrete structures	Guardrails must be present and painted. Beams all other structural parts must be in good conditions and fully functional. Drainage system in good condition and fully functional.	Visual inspection	Guardrails damaged by accidents must be replaced within seven (7) days.
Expansion joints	Clean and in good condition	Visual inspection	Damages and defects must be repaired within seven (7) days.
Retention walls	Contractor must control presence and adequate condition of retention walls and their drainage.	Visual inspection	Contractor must immediately notify Project Manager in case of any condition which threatens structural integrity of bridge.
Riverbeds	Contractor must ensure free flow of water under bridge and up to 100 meters upstream. Contractor must maintain design clearance under bridge.	Visual inspection	Causes for non-compliance must be eliminated within fourteen (14) days after water has sufficiently receded to allow minimum working conditions.

Source: (World Bank, 2002)

2.3.14.3 Drainage Systems

According to World Bank (2002), the service quality level requirements for Drainage structures are as shown in the following table:

Table 2.6: Performance service level criteria for Drainage System

Item	**Service quality**	**Detection**	**Time allowed for repairs or Tolerance permitted**
Ditches and vertical drains with lining	Must be clean and lining without any significant damage of the lining.	Visual Inspection	Tolerance permitted: Obstructions equivalent to less than 10% of capacity of item and must be cleared within seven (7) days after detection. Damages must be repaired within three weeks after detection.
Ditches and vertical drains without lining	Must be clean and free of obstacles.		
Collectors	Must be clean and free of obstacles, and without structural damage. Must be firmly contained by surrounding soil or material.		
Culverts and similar	Must be clean and free of obstacles, and without structural damage. Must be firmly contained by surrounding soil or material.		

Source: World Bank (2002)

2.3.2 Normal measurement contract/Traditional contract

According to ERA, Traditional road maintenance contracts are contracts in which the Contractor is responsible for the execution of works, which are normally defined by the Road Administration or the Employer and the Contractor is paid on the basis of unit prices for different work items, i.e. a Contract based on "inputs" to the works. The results of traditional Road Contracts are in many cases less-than-optimal. The problem is 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. Even if the work is carried out according to plan and considerable money is spent, the overall service quality for the Road user suffers from deficiencies in the original design, aggravated by inadequate maintenance

Table 2.7: Traditional road maintenance Contracting systems.

Contract Types	Definitions	Suitability
Short Term Contracts		
Normal measurement contract/Admeasure contract	Required quantities of each activity are listed on a bill of quantity (BoQ). The price is submitted and used by the road agency to assess bids and award the contract. Typically, the quantity of completed work that meets the technical specification is measured monthly, and the contractor is paid for that quantity multiplied by the contract unit rate.	Periodic maintenance and rehabilitation.
Simple Measurement contract	For work on a larger scale, quantities are estimated, measured, and paid as usual, but the BoQ includes fewer items. Requires skilled inspectors to ensure that all necessary work is carried out under the composite activities.	Can save on measurement costs
Cost plus contract	Actual costs incurred by the contractor are paid, plus an agreed percentage for profit. Generally not cost effective, and the contractor has little incentive to provide high-quality output.	For contractors undergoing training or for items of work where a specification is difficult to set.
Contract Types	**Definitions**	**Suitability**
Long Term Contracts		
Term measurement contract	Based on a schedule of unit prices and estimates of quantities listed in BoQ. Bids are assessed and contracts awarded as above. Contract specifies activities to be performed and timing and may include an emergency response capability. Payment is based on inputs (amount of physical works executed and amount of material supplied).	For routine maintenance. When funding is unreliable
Length worker contract	A type of performance contract for one person to implement routine maintenance works on an allocated length of road (normally 1–2 km). The contractor is often paid monthly based on a specified work time. Performance standards should be specified, and contractors should be paid for performance rather than attendance. Length workers can be subcontracted to a larger contractor, to avoid the high costs of administering many small scale contractors.	For routine maintenance if contractors are adequately trained and supplied with needed equipment and material.
Community contract	Payment is based on measurement or performance. Contracts are often awarded on agreed rates rather than tendered, but if other community contractors are interested, technical proposals may also be assessed. Contract documentation should be transparent and easy to understand by those unfamiliar with contracting. A contract may provide for assistance from a road agency or assign complex work to a commercial subcontractor.	For contractors that have emerged from the local community

Source: Heggie and Vickers 1998; TRL and DFID 2003

2.3.3 Differences between Performance Based Contracts and Traditional contracts

The idea that risks should be borne by the party that can manage them best is acknowledged in the literature (Queiroz 2000; Amos 2004). What significantly differentiates a PBMC is that the contractor is assigned a number of the responsibilities and risks that used to be borne by the owner agency under traditional method-based contracts. On the one hand, the contractor is not tied down by the contracting agency in making his decisions regarding "what to do", "when to do" and "how to do". He is free to innovate with techniques and technologies to reduce his own costs, as long as the level of service specified in the bidding documents is achieved (WB 2004). On the other hand, the contractor now bears the entire risk in case of failure of his management and innovation – his errors in (i) predicting deterioration of contracted assets; (ii) determining appropriate design, specifications and materials (conforming to the country"s standards); (iii) planning needed maintenance interventions; and (iv) estimating quantities (World Bank, 2005).

The selection process in performance-based contracting is normally based on "the best value", which may not be necessarily "the lowest bid". Since the contractor carries more risks and management responsibilities, the contracting agency wants to ensure management capacity with the potential contractor, his clear understanding of the new approach, the new responsibilities and his ability to handle the associated risks. The selection process involves choosing a contractor who has the capability to assess the condition of the assets, determine the timing of interventions, select materials and work methods, a suitable work plan and arrange the monitoring of his own services. Only after ensuring that the bidders are sufficiently qualified (normally through a pre-qualification process), does the selection process consider cost proposals. The "best value" approach tries to ensure a high quality product at a low overall cost. Payment in PBCs is made on a fixed price lump sum basis normally through uniform installments, linked to continuing to meet performance targets. The contractor is not paid for physical works completed, but for the final results (or levels of service) he has delivered **(**World Bank 2005).

The duration of PBCs is typically longer than that of traditional contracts as the contractor carries greater risk and responsibility and is obliged to undertake certain maintenance interventions that occur every few years. Use of PBC requires the existence of a mature and

well-developed contracting industry with capability to undertake long-term management of contracted assets, assume additional risks, and establish necessary programming and quality assurance mechanisms. In case of comprehensive PBCs, this is often achieved through formal collaboration between construction management firms and traditional road contractors (World Bank 2005).

2.3.4 Overview of International Practices on Performance Based Contract

2.3.4.1 Canada

In Canada, the development of performance-based contracts for road maintenance started in the late 1980s and early1990s. British Columbia piloted the first PBMC in 1988 (Zietlow, 2005a). Performance standards still leaned toward required work procedures rather than outputs or outcomes. British Columbia now uses performance-based contracts to maintain 100% of its provincial highways (Stankevich *et al.,* 2006).

Since 2003, British Columbia has made lump-sum awards for performance-based maintenance contracts with 10-yearperformance periods. The contracts address maintenance and repairs and do not include resurfacing, rehabilitation, and reconstruction. The services include surface maintenance, winter maintenance, drainage, landscaping, structures maintenance, sign work, emergency maintenance and repairs, and fixing damage to government property. A variety of work is quantified and serves as the basis for performance measurement and incentives. Performance standards are proactive and customer-oriented. The transportation agency does not prescribe the methods for doing work. Each month contractors receive one-twelfth of the annual lump sum award provided that all performance standards are met; otherwise, deductions occur (NCHRP, 2009). The cost savings for the 10-year, lump-sum, and performance based contracts has been estimated at 10% (Stankevich *et al.,* 2006). Pakkala (2002) asserted cost savings, but no quantitative estimate was provided.

In the province of Alberta, PBMC was an outgrowth of a premier‟s initiative to reinvent government. Failure to meet the contract performance criteria results in penalties. In Alberta, the contract term is 5 years with a renewal term of 1 to 3 years. Price receives the majority of the weight in the contractor selection criteria (Stankevich *et al.,* 2006).

According to skinner (2007), Ontario, another province of Canada uses 95% lump sum performance based contracts ranging from 7-9 years. The contracts include all routine maintenance such as pothole repair, vegetation management, bridge maintenance and cleaning, electrical work, and line painting. Other types of work addressed include winter maintenance, patrolling to conduct visual inspections, and emergency assistance to deal with accidents and spills. Maintenance performance standards include both outcome and time-based performance criteria. Failure to meet the standards can result in penalties. Over time, the duration of the contract period has been increasing gradually and the number of maintenance activities has grown (Stankevich *et al.,* 2006).

Table 2.8: Cost saving in Alberta Canada using PBMC.

Contract Description	**Source**	**Cost Saving**
Two rounds of tenders of hybrid contracts eventually covering 100%of provincial roads in 30 Contract Maintenance Areas (CMAs)	(World Bank, 2006)	• 5% savings for first round of tenders; • 25%–35% savings for second round of tenders
	(Pakkala, 2002)	Clients receive some cost savings (did not provide any quantitative estimates or supporting data)
	(Bucyk and Lali, 2006)	a 28% reduction in cost between the new contracts (year 2000) and the old contracts (prior to 2000), which translates into a reduction in unit prices to $3,705/km from $5,117/km, representing a total annual cost reduction of $26,419,932.

Source: (NCHRP, 2009)

2.3.4.2 Australia

Australia is composed of six states and two territories, a number of which have been among the world leaders in using performance-based maintenance contracts. One of the first jurisdictions to try this type of contract was New South Wales. In 1990, this state began a comparative study of two 100 km pilot projects in Sydney.

According to the World Bank, the objective of the study was to determine the feasibility of contracting road maintenance and to estimate differences in cost, quality, and responsiveness between a contractor and the RTA‟s workforce (Stankevich *et al.,* 2006).

According to NCHRP (2009), citing (Stankevich *et al.,* 2006) State forces performed the maintenance work in one pilot project and a private contractor conducted the maintenance work in the other. Results also were compared with work done by the in-house force. The RTA of New South Wales first awarded a management contract to a contractor those urban roads (or 1,900 lane-km) in Sydney. The most important performance criteria were average roughness and cracking. The World Bank reported a 13% improvement in condition accompanied by a cost reduction in the 20% to 30% range, but it is not known over how many years of the contract these results apply. The bid price was 25% lower than estimated. Segal *et al.* (2003), referring to the Reason Public Policy Institute reported that since New South Wales started this performance contract, roadway condition has improved approximately 15% and there has been a 35% cost savings (Segal *et al.*, 2003).

Since then several new contracts have been let in New South Wales, Tasmania, and Southern and Western Australia. A number of them are hybrid contracts, in which some of the maintenance is paid based on both quantities and performance standards (Zietlow, 2005a).

Table 2.9: Cost saving in Alberta Australia using PBMC

Jurisdiction(s)	**Source**	**Savings**
Regional Transport Authority, New South Wales; Tasmania; Western Australia	Pakkala 2002)	10% to 35% (bases for comparison not known)
Sydney, New South Wales	(Frost 2001)	38% cost savings compared with schedule of rates type of contracts
Southern Tasmania	(Frost 2001)	20% cost savings compared with schedule of rates type of contracts
South Perth	(Frost 2001)	25% cost savings compared with schedule of rates type of contracts
Mid North Region	(Frost 2001)	30% cost savings compared with schedule of rates type of contracts
Six contracts in Western Australia	(Frost 2001)	Savings of 15% to 20% against other forms of maintenance contracting, which in turn were reported to have achieved 20% savings against in house operations. Thus, total savings compared with in-house operations are estimated to be at least 35%.

Source: (NCHRP, 2009)

2.3.4.3 New Zealand

In New Zealand, the national road agency is known as Transit New Zealand (Transit NZ). In 1998, it let its first long-term performance-based maintenance contract known as a Performance-Specified Maintenance Contract (PSMC). Today, lump-sum PSMCs with 10-year terms are used on 15% of the nation‟s entire road network, mainly on national roads. Contractors must satisfy a detailed set of key performance indicators. Recent PSMCs measure performance at three levels: management, long-term, and operational measures. The first set of performance measures concerns contract management and implementation. The second set the long-term measures pertains to the condition of the pavement and addresses such attributes as roughness, texture skid, and structural integrity. The third set operational measures include the condition of the appurtenances along the road, the effect on serviceability, and the user‟s experience.

Transit NZ also has hybrid contracts that incorporate features of both method and performance specifications. A large number of the performance standards are expressed in terms of intervention times. The term of the hybrid contracts is only 5 years (Stankevich et al., 2006). Industry experts have asserted that these PSMCs have resulted in improved maintenance service and road quality. The general manager of Transit NZ reported that better services were delivered. It is unclear whether this statement applies to a hybrid contract (with both performance and method specifications) or to a long-term performance-based maintenance contract. An expert on PBMC wrote that there were pronounced improvements in the quality of service, bumps, skid resistance, signs, drainage systems, and market posts for a well-known performance-based contract (Pakkala, 2002).

Table 2.10: Cost saving in New Zealand using PBMC

Contract(s)	**Source**	**Savings**
10-Years, lump-sum, performance-specified maintenance contracts on part of the national road network and highway works throughout country;	Reason Public Policy Institute	20% savings based on regular audits
	World Bank	Less cost according to General Manager of Transit New Zealand
	Highway Maintenance Contracting	30% decrease in cost of professional services and 17% decrease in costs of professional services; a savings of at least25% over conventional model
10-Years,lump-sum, performance-specified maintenance contract (PSMC-001) covering 450 km	Pekka Pakkala	Initial savings were about 25%, and were between 14% and 20% at time report was written. Savings predicted to be 25%.

Source: (NCHRP 2009)

2.3.4.4 United Kingdom

The UK Highways Agency is responsible for 8,850 km of the most strategically important part of the nation‟s highway network. This portion of the highway system amounts to only 4% of the total roadway miles in the United Kingdom, but it carries 30% of the total traffic and 60% of the truck traffic. Performance-based maintenance contracts are known as Managing Agent Contracts (MAC) in the United Kingdom. These contracts incorporate performance specifications to increase efficiency and effectiveness, allocate responsibility and risk between the client and the contractor, foster innovation, and focus the attention of the contractor on outcomes. Some important characteristics of MACs are as follows:

- Increased outcome orientation
- Lump-sum and unit prices as a basis for payment
- Strengthened partnering
- Emphasis on continuous improvement
- Focus on life-cycle costs
- Better risk management

- Supply chain management (Pakkala 2002; Harding2005).

According to Harding (2005), little is published or easily accessible regarding changes in costs regarding PBMC in the United Kingdom. An article published in the proceedings of a seminar on the state of the practice regarding PBMC around the world reported that it is difficult at this time to determine the effectiveness of the MACs. The author wrote that there is some overall evidence that service has improved with slightly reduced costs, particularly with respect to routine maintenance.

2.3.4.5 Finland

In 2001, Finnra undertook a major reorganization. The part responsible for design, engineering, and maintenance and operations was transformed into a wholly state-owned production organization known as the Finnish Road Enterprise (FRE) to compete with the private sector regarding capital, maintenance, and operations projects. Finnra remained the client organization responsible for procuring contractors and entering into contracts. Initially, public tendering began in 23of 99 maintenance areas on the network. Because of the potential impact of the FRE on the competitive position of existing private firms, the FRE was introduced gradually into the mix of contractors. Full and open contracting involving the FRE throughout the country did not start until 2005. The original 23 maintenance area contracts were lump-sum, mainly output (accomplishment). A few were outcome-oriented, and these were 3-year contracts. The contractor selection criteria were based 75% on price and 25% on technical qualifications (Pakkala, 2002).

As of approximately 2005, Finnra maintenance contracts were hybrids, 75% of compensation based on a lump-sum payment with adjustments for failing to meet performance criteria, and 25% based on unit price. The outcome-based portion of the contract, covered by the lump-sum payment, concerned winter and summer maintenance, minor bridge maintenance, gravel roads, vegetation management, and drainage and culvert maintenance, among other things. For example, intervention time and outcome specifications for winter maintenance required the contractor to respond to snow conditions within 2 hours, remove all snow to no more than 1 cm within a certain amount of time after it stops snowing, and achieve a measure of skid resistance

of less than 0.3 (NCHRP, 2009). Finnra enters into separate unit price contracts to address lighting, road markings, traffic signs and signals, resurfacing, and rehabilitation (Stankevich *et al.,* 2006).

Table 2.11: Cost saving in Finland using PBMC

Source	**Savings**
Finnish Road Enterprise	Cost savings analyzed at 7% to 10% for 3-year contracts and 13% for 7-year contracts
World Bank (Stankevich *et al.*, 2006)	7% to 10% for 3-year contracts and 13% for 7-year contracts; the current price level is 50% to 60% of the price level when Finnra was using its own labor and equipment to do maintenance
World Bank Transport	30% to 35%; about 50% less cost/

Source: (NCHRP, 2009)

2.3.4.6 Latin America

The average condition of one-third of the roads in developing countries is poor. In Latin America, the condition of roads is even worse. A few years ago it was reported that only 7% to 52% of roads were in good shape. Even in the best-case scenario, nearly half of the roads are in poor shape (Segal *et al.,* 2003). In an effort to improve road conditions and reduce maintenance costs, Argentina and Uruguay were pioneers in adopting performance-based contracting models (NCHRP, 2009).

Argentina: Since 1995 Argentina has pursued a number of different contracting approaches involving performance-based maintenance, including kilometer/month contracts for routine maintenance, *Contrato de REcuperacion y MAntenimiento* (CREMA) Phase I, Phase II, and concessions (NCHRP, 2009).

Argentina‟s national system of roads totals 38,744 km, of which 30,912 km are paved and 9,508 are concession toll roads. In 1995, Argentina launched a series of performance based maintenance contracts covering about 3,600 km of these national roads. The government selected paved roads in fair to good condition for 11 maintenance contracts, each varying from 105 km to 536 km for a total of US $650 million (NCHRP, 2009).

Contracts were lump-sum and payments were made each month according to an amount per kilometer (based on equivalent liters of gasoline to account for inflation but expressed here as dollars/kilometer/month). The contracts were for two years and were renewable. Three inspections, based on a sampling process, occurred once per month. If one or more deficiencies was found with regard to performance targets both technical specifications and response times the road agency made deductions from payments in accordance with a table of penalties. Performance standards addressed specific measures concerning ride quality, safety features, and aesthetics including vegetation. Penalties were imposed gradually to give the contractor an opportunity to address the deficiency, but would reach 100% of the penalty if the problem was not redressed by the third inspection at the end of the month (NCHRP, 2009).

These kilometer/month performance-based maintenance contracts were judged to have worked well. The average cost of routine maintenance was $175/km/month and penalties resulting from 600 instances of noncompliance totaled only $ 300,000, approximately 1% of the value for all the contracts (Cabana *et al*., 1999). Because the first phase of CREMA performance-based contracts began with rehabilitation followed by maintenance, it had a significant effect on asset condition. The percent of roads in good to fair condition increased from 59% to 94%.The percent in critical to poor condition declined from 41% to6%. Also, roughness measurements deteriorated at a slower rate than predicted by the HDM (Stankevich *et al.,* 2006).

A report of the Reason Public Policy Institute states that Argentina has achieved reduced costs of maintenance, better Roads, new capital investment in the highway network, and a reduction in the government‟s maintenance workforces; it also largely eliminated corruption in highway maintenance and rehabilitation (Segal *et al.*, 2003).

Uruguay: Beginning in 1996, the Ministry of Public Works introduced performance-based contracts for the maintenance of Uruguay‟s national highway network. There were essentially two types of contracts; one concerned with routine maintenance and the other involved initial rehabilitation followed by periodic and routine maintenance. It used a performance-based contract similar to Argentina‟s that involved both rehabilitation and periodic and routine maintenance. Rehabilitation occurred on selected sections of highway before maintenance occurred. By the start of 2000, more than 40% of the national road network was being maintained under 5-year, performance-based maintenance contracts (Zietlow, 2005b).

In 1996, as Uruguay started transforming its road contracting process, Montevideo commenced its first performance based contract for nearly 140 km of its city roads. The city entered into a 3-year contract with a 3-year extension. Portions of the network needed initial rehabilitation. Montevideo paid the contractor based on unit price for the rehabilitation work. During the 3-year extension, the contract called for cutting monthly payments by 40% because of the rehabilitation work that previously occurred (NCHRP, 2009). The city defined performance standards, response times, and penalties for noncompliance for pavements, shoulders, and drainage systems. Because road conditions at the start of the contract were significantly below the performance standards in the contract, the contractor had between 3 months and12 months to bring the assets up to the required standards. Because the first contract proved to be successful, Montevideo pursued two additional contracts, one involving gravel roads (Zietlow, 2005b). Shortly thereafter, other Latin American countries, such as Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, and Peru, also started adopting or planned to adopt a performance-based approach (NCHRP, 2009).

2.3.4.7 Chad

Chad‟s first performance-based road management and maintenance contract occurred in 2001 with the assistance of the World Bank. The 4-year contract addressed 440 km of unpaved roads. A French firm was the contractor and used mainly local labor. A Cameroon engineering firm provided contractor over sight. Elements of the contract included the following:

- Management and maintenance as • well as self-monitoring of the contractor
- Rehabilitation over the first 21 months of the contract
- Rebuilding or replacement of drainage structures and signs
- Emergency help for those in accidents
- Rain erosion and axle load control; and
- Other emergency works as needed.

The contractor received a fixed monthly fee based on a lump-sum for the contract period. However, the contractor was paid on the basis of unit price for emergency work. A performance guarantee was equal to 10% of the contract value. The contractor received an advance payment of 20%to perform the rehabilitation. The total cost for road management, rehabilitation, and maintenance was estimated at US $5,740/km. Thanks to the performance-based contract, the road was upgraded to excellent condition. Users appreciated that the road was kept in good condition after the rehabilitation was completed. Cars and trucks were able to use the road during the rainy season, which was not possible before the roadwork occurred. A negative side-effect of the improved road quality was that the accident rate increased as travel speeds increased. As of 2004, no other significant difficulties were reported and the contract was judged to be a success (Zietlow, 2005b).

2.4 Road Management in Ethiopia

2.4.1 Ethiopian Roads Authority

In 1951, when the Ethiopian Roads Authority was established, the total road network amounted to 6,400 km. This network was built mainly during Italian invasion. By 1997 the road network had grown to 26,550 km, of which 3,708 km were paved. As a result of investments under RSDP I and RSDP II the current length of the network has reached 42,429 km, of which 5,452 km (12.8%) are paved and the remaining 36,977 km (87.2%) are unpaved. Of the present classified road network, about 20,080 km are considered as the main road network administered by the Federal Government (Ethiopian Roads Authority) and the remaining 22,349 km of "low level" roads, generally categorized as "rural roads" under the Regional Rural Roads Authorities (ERA,

2003).

ERA is responsible for the planning, construction, maintenance and administration of Federal Roads. For the last 10 years (1997-2007) with RSDP I and RSDP II programs, the Ethiopian Roads Authority invested more than ETB 20 billion for the construction and maintenance of federal roads. In terms of funding by category of financiers, a little more than 63% has come from internal sources (the Government, the Road Fund and the Community) while the remaining amount of funds (37%) has been pooled from the international community (Nagawoo, 2008). ERA has been carrying out the maintenance of roads by the district maintenance contractors, which is recently established as a separate enterprise that is ERCC.

2.4.2 Road Fund Administration

In the early 1990s, it was recognized that the limited extent and poor state of the road network had become a major constraint on measures taken to revive Ethiopia,,s economy. In 1995, only 11 per cent of paved roads and 19 per cent of unpaved roads were in an acceptable condition. Major trunk roads accessing ports and economically important areas were in disrepair. To tackle these problems in 1997 the Government launched a 10 year Road Sector Development Program (RSDP). The program attracted a great deal of donor support and involved a major program of investment (Nagawoo, 2008).

As part of the RSDP it was recognized that road maintenance funding had to be improved. In line with the World Bank sponsored Road Maintenance Initiative (RMI) a road fund was established in Ethiopia in 1997 through proclamation by parliament. The Road Fund Board is chaired by the Minister of Works and Urban Development. Other members of the board include three Vice Ministers, six Regional Presidents or representatives, the general manager of the Ethiopian Roads Authority, four representatives of road transport owners and the general manager of the Office of the Road Fund Administration. Membership of the Board is for two years (Nagawoo, 2008). The fund was established with the objective to finance road maintenance and road safety activities through a dedicated road user payment fund. Revenue sources of the fund were identified as:

- The government budget
- A fuel levy

- A vehicle license renewal fee based on vehicle axle weight and configuration
- Overloading fines
- Other road tariffs that may be fixed as necessary

The Board is empowered to issue directives to define collection and disbursement procedures of the Fund (including the recommendation of additional sources and levels of tariffs required to finance road maintenance) and ensure the timely collection and deposit of revenues. It must review the annual road maintenance programs of the road agencies and submit to the government proposals for works to be financed by the Fund. It should ensure the transparency and accountability of disbursements, receive and review management reports from Road Agencies, initiate financial and technical audits of road maintenance and road safety measures (Nagawoo, 2008).

In order to receive road fund revenues each road agency has to have a separate Road Fund account purely for road maintenance. Deposited money can be used on a rolling basis from year to year. This is unlike Ministry of Finance budget accounts that must be used within each budget year. The separate accounts help prevent the mixing of funds for maintenance with other activities. Likewise it helps road fund auditing to take place separately from other accounts.

The basic allocation of funds has been on the basis of 65% to the Federal Roads (i.e. for the ERA), 25% is allocated to the regions and 10% to selected municipalities. The regional allocation has been divided on the basis of a weighted average ratio with an 80% weight to road length and a 20% weight to population. The remaining money is distributed to the municipalities on the basis of population size and regional centrality with Addis Ababa accounting for half the allocation (Road Fund Administration) (ERA, 2014).

2.4.3 Ethiopian Road Construction Corporation

Ethiopian Road Construction Corporation (ERCC) is a new government development agency; which was under Ethiopian Roads Authority. Council of Ministers Regulation No 248/2011 has established ERCC on July 08/2011 to carry out mainly road and bridge construction, maintenance and enhancement works. Before ERCC was established it was working as operation using of Ethiopian Road Authority (which changes its name and internal organization structure)

for 60 years and has acquired the experience of road maintenances.

- As consultant 12000 km per year road maintenance
- "Term" Maintenance
- Average 30 seasonal road maintenance every year
- Urgent or emergency road maintenance

Table 2.12: Road Maintenance Districts under ERCC

Maintenance Project Name	**Covered Distance (KM)**		**Total Covered Distance (KM)**
	Asphalt (KM)	**Gravel (KM)**	
Alemgena	1601	2184	3785
Adigrat	567	1090	1657
Kombolcha	119	1005	2124
Debre-Markos	335	1172	1527
Gondar	761	688	1449
Shashemene	593	2123	2716
Dire Dawa	1393	1467	2860
Nekemte	547	1238	1785
Jimma	582	1980	2562
Sodo	777	1189	1966
Total	**8295**	**14136**	**22431**

Source: (ERCC, 2012)

2.5 Assessment of Road Maintenance in Ethiopia

2.5.1 Introduction

Past failure to undertake adequately funded, planned and managed maintenance programs have led to the situation where the massive capital investments of the Road Sector Development Program (RSDP), have become necessary. However, the lessons of the past have been well learned by the Government and the Ethiopian Roads Authority (ERA), and much attention is now being focused on maintenance tasks (ERA, 2014).

The total federal road network of which is being administered by ERA has reached to 26,857 km as of July 2014. Overall road network in Ethiopia has been increasing on the average by 3.2%

each year between 1997 and 2014. The table below summarizes impact of works undertaken between the year 2002 and 2013 measured in terms of selected indicators.

Table 2.13: Change in selected indicators

Indicators	**1997**	**2002**	**2007**	**2013**
Proportion of Asphalt roads in Good Condition	17%	35%	64%	71%
Proportion of Gravel roads in Good Condition	25%	30%	49%	36%
Proportion of Total Road network in Good Condition	22%	30%	49%	51%
Road Density/ 1000 sq. km	24.1km	30.3km	38.6km	78.2km
Road Density/ 1000 Population	0.46km	0.49km	0.55km	1km
Proportion of area more than 5km from all-weather road	79%	75%	68%	46%
Average distance to all weather road	21.4km	17km	13km	6km

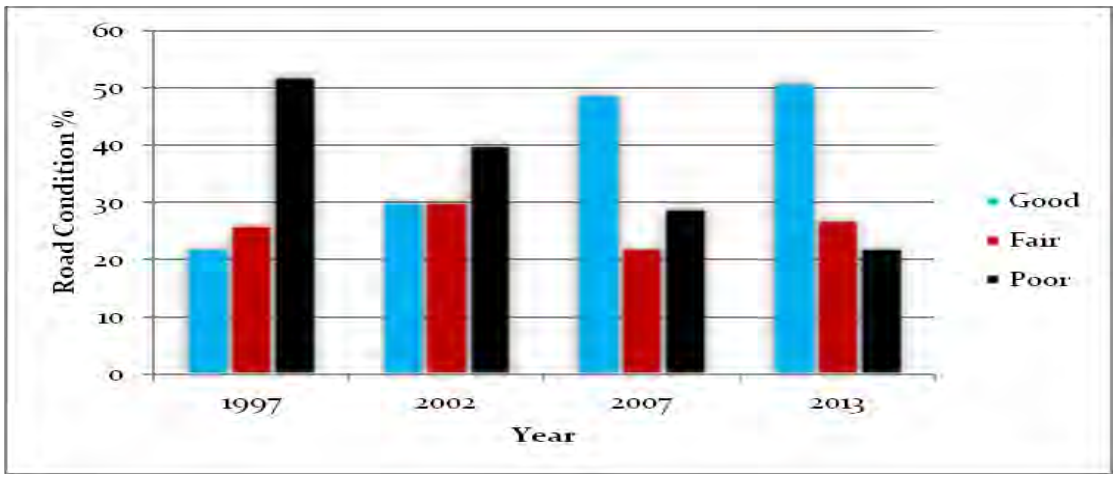
Source: (ERA, 2014)

Improving the condition of the road network is still a challenge. The improvement of the road network in the country is only changing the condition of the network slowly. In the first year of RSDP, 52% of the road network was found to be in poor condition and only 22% was in reasonably in good condition. Owing to on-going rehabilitation, upgrading and maintenance intervention under the program, the proportion of the road network in good condition has increased to 50 percent and the road in poor condition has declined to 22%. The proportion of roads in good condition has overtaken the proportion of roads in poor condition from 2004 onwards and particularly the last two years owing to a massive intervention in terms of rehabilitation, upgrading and maintenance on major roads. Another observation is that the roads in fair and poor condition are consistently declining shifting to good condition since the year 2002. The road condition from year 1997 to 2013 is presented below (ERA, 2014).

Table 2.14: Road Condition Improvement from year 1997 to 2013

Year	**Good**	**Fair**	**Poor**
1997	22	26	52
2002	30	30	40
2007	49	22	29
2013	51	27	22

Source: (ERA, 2014)



Graph 2.2: Road Condition Improvement

2.5.2 Road Maintenance in the Past

At the early 1990s, the road network was generally deteriorated due to long time neglect of routine and periodic maintenance. Potholes, ruts, gully, depletion, silting of side drains, and blockage of culverts and bridges, etc. was characteristics of Ethiopian roads. The extent of the crisis was fully revealed during the Spanish Consultant financed by European Commission in 1995. Only 11 per cent of the 3,656-km of paved roads were deemed to be in an acceptable condition, 41 per cent was deteriorating fast and the remaining 48 per cent were beyond repair. The 20,156-km unpaved network was in a worse condition, with only 19 per cent in acceptable condition, 28 per cent mediocre, and 53 per cent in a poor state. This severe condition was ameliorated by 2007 whereby 49 per cent of the then 42,429 km was in good condition and 22 and 29 per cents of the total network were in fair and poor condition respectively. However, after ERA administer the federal road network only, the percentage of the road segment in good and fair condition has increased in the year 2013 to 51 and 27 per cents respectively (ERA, 2014) (Table 2.15).

Table 2.15: Condition of roads 2014

Year	Condition of Roads (%)		
	Good	**Fair**	**Poor**
1995	18	29	53
2007	49	22	29
2014	51	27	22

Source: (ERA, 2014)

The consequence of this situation was grave, and vehicle-operating costs were increasing from time to time. The extra road user costs resulted in increased transportation costs that would be transferred, through operators and shippers, to the final consumers of the service. In general, road infrastructure was deteriorating to such an extent that they were hindering rather than facilitating the movement of people and goods. This was the direct consequence of inadequate maintenance fund and failing to provide the road as per its requirement. Specific problems encountered in carrying out both routine and periodic maintenance were:

- Inadequate funding for works;
- Capacity limitation due to limited equipment, spare parts and materials;
- Giving more priority to new construction;
- Institutional problem of many nature; and shortcoming in maintenance planning/prioritization;

Therefore, the resulting outcome was as mentioned before deterioration of big proportion of the road network (ERA, 2014).

Routine Maintenance is a continuous activity that does not depend on the engineering characteristics of the road or volume of traffic. Routine maintenance is undertaken on a regular basis and includes grass cutting, clearing ditches, culvert maintenance, drainage clearing, road signs maintenance etc. It was realized that the sustainability of the major achievements of the RSDP depends critically on timely and efficient maintenance of the network. The required cost for routine maintenance work is entirely covered by the Road Fund.

The total cost planned to be disbursed for federal, regional and urban roads routine maintenance as of June 2007 was 1903.8 million, whereas the amount disbursed during the same period amounted to Birr 2471.0 million. Out of the total maintenance expenditure Birr 1524.6 million (61.7%) is for federal roads, Birr 663.4 million (26.8%) for regional roads, and Birr 283.0 million (11.5%) is for urban roads. Currently, 49 per cent of the 42,429 km of total road network is found to be in good condition while 29 per cent is in poor condition (ERA, 2014).

2.5.3 The Funding and Expenditure of Road Maintenance

Table 2.16 below provides details of planned allocation, accomplishment and disbursement for road maintenance over the last ten years. Routine maintenance is now entirely funded by the Road Fund. Currently, 65 per cent of the regular Road Fund Budget is allocated to the Ethiopian Roads Authority for the Federal Network, 25 per cent is allocated to the Regional Road Authorities and 10 per cent to the Municipalities.

Table 2.16: Maintenance Budget and Disbursement on the Federal Network (Birr in Millions)

Year	Routine and Periodic Maintenance			Emergency and other Works		
	Budget (Million)	**Disbursement (Million)**	**% Age Acc**	**Budget (Million)**	**Disbursement (Million)**	**% Age Acc**
1997/98	158.4	117.9	74.4	10.8	5.6	51.9
1998/99	156.9	123.5	78.7	15.2	12.5	82.2
1999/00	152.0	118.2	77.8	17.0	15.2	89.4
2000/01	114.0	140.4	123.2	70.8	27.8	39.3
2001/02	119.7	176.2	147.2	178.0	31.0	17.4
2002/03	121.5	115.7	95.2	35.1	68.6	195.4
2003/04	127.0	192.8	151.8	163.2	140.5	86.1
2004/05	63.5	137.1	215.9	162.2	482.6	297.5
2005/06	144.1	172.5	119.7	112.4	298.4	265.5
2006/07	150.0	230.3	153.5	257.8	394.7	153.1
2007/08	186.7	234.8	125.7	161.3	400.6	248.3
2008/09	227.8	527.8	231.7	200.7	500.7	249.4
2009/10	223.4	516.9	251.5	196.2	491.1	250.3
2010/11	158.9	368.1	231.6	140.0	367.4	262.4
2011/12	426.9	493.1	115.5	320.3	310.9	97.1
2012/13	302.1	440.7	145.8	439.9	410.2	93.2
2013/14	516.8	577.2	111.6	370.9	376.1	101.4

Source: (ERA, 2014)

2.5.4 Road Maintenance Procedure

ERA identifies defects, determines the type and level of intervention required, and apportions the budget for a Ethiopian Fiscal Year (EFY) for each road segment. It then issues a series of Work Orders to ERCC to carry out certain quantities of different types of work in a road segment (approx. 50km). When it receives a specific maintenance contract (i.e. Work Order), ERCC shall plan Road Maintenance Works by:

- Identifying and determining ERA‟s requirements; and
- Making use of all ERA‟s planning procedures and guidelines for condition surveys, defect identification, intervention planning, prioritization tools, etc (Smec, 2014**).**

According to Smec inception report (2014), ERA‟s Work Orders may not identify the locations of the work items to be carried out, but may state only that a certain type of work (e.g. 300 Esq. of pothole repairs) is to be carried out in a particular segment of road. In this case ERCC is then responsible for determining the order of priority of defects in the segment and for carrying out the specified quantities of Different types of repair. The report further emphasized that ERCC conducts maintenance only when it receives a Work Order from ERA. ERCC shall not exceed the value of the Work Order unless this is authorized by ERA. The following parties hold maintenance supervision

- Routine maintenance is usually not supervised closely by ERA or other clients.
- Periodic maintenance is dealt with on a project basis as a small contract and is frequently supervised by an independent consultant.
- Emergency maintenance is ordered by ERA and paid on a day works basis.

2.5.4.1 Road Maintenance Activities

ERCC shall implement road maintenance activities using ERA‟s maintenance requirements, which include:

- Working in accordance with the Technical Specification for Road Maintenance Works, 2nd Edition, August, 2003;
- Repairing defects in the segments nominated by ERA, according to the priority determined

by ERCC‟s inspection, or as otherwise instructed by ERA and

- Recording and reporting the maintenance works completed in the specified road segments (source ERCC).

2.5.4.2 Defect Identification

Unless otherwise specified by specific contract conditions, Road Asset Defects in the road network shall be identified by ERA. However, if so permitted, ERCC shall make use of all ERA‟s procedures and guidelines to carry out inspections to survey road condition, and document defects in the road network in accordance with ERA‟s Asset Inspection System; and identify any defects, which have reached the Intervention Levels nominated in ERA Specifications.

Once ERA has identified defects and issued Work Orders to ERCC for repairs, ERCC shall then inspect each road segment to establish which particular defects should have priority within the funding limits of the work that they have been authorized to do (Smec, 2014). ERCC should obtain ERA‟s approval for their proposed priority for defect repairs, if this is required, and for any suggestions that funds should be transferred to one type of repair in preference to another repair, which ERCC considers to be less critical. When and where ERCC identifies defects, which have not been identified by ERA previously, then ERCC should inform ERA of these defects.

2.5.4.3 Bidding Strategies for Maintenance Projects

Maintenance projects are also apportioned every year based on fixed prices for work items negotiated when ERCC was within ERA, so there is presently no practical trend / experience that can be discussed with regards bidding strategy, processes and procedures. ERCC‟s draft Transformation Plan (in Amharic), with regard to pricing, states that it must be fair and competitive when addressing the Stakeholders‟ analysis (Smec, 2014).

2.5.4.4 Road Maintenance Activity unit rates

According to Smec (2014), it is noted that the current activity unit price was developed some years ago, possibly in early 2000 E.C, and has been not been revised since then. The cost of

materials, labor rates, and machinery rental rates has increased many times in the intervening period. In 2005, ERA had commissioned a study aiming to structure unit rate analysis for maintenance works to be used for negotiations with Road fund, but the unit rates have not been revised since 2000 (EC) (that is around 2008 (GC)). In fact, the prices of cost components have increased considerably since 2000 (EC) and yet it was also noted that generally RMPs have been recording profits each year (Smec, 2014).

2.5.4.5 Performance Based Maintenance

Performance-based contracting for the management and maintenance of roads is a recent model designed to increase the efficiency and effectiveness of road maintenance operations. It should make sure that the physical condition of the roads under contract is adequate for the need of road users, over the total period of the contract which is normally several years. This form of contract significantly develops the role of the private sector, from the simple execution of works to the management and conservation of road assets.

One fundamental feature of the performance-based contract is that the Contractor is responsible for designing, scheduling, and carrying out the actions he believes are necessary in order to comply with the service quality levels stated in the contract. 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. Under the performance-based contract, the Contractor has a strong financial incentive to be efficient. In order to maximize profits, he must reduce his activities to the smallest possible volume of intelligently designed interventions, which nevertheless ensure that pre-defined outputs (measured indicators of service level) are achieved and maintained over time. To start a performance based maintenance contract, ERA intended to employ the services of a qualified consulting firm to provide support for the preparation and procurement of a pilot performance-based contract for the management and maintenance of a still to identified selection of roads. The network of road to be included in the contracts will total approximately 1,000 km and will include both paved and unpaved roads.

3. RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The aim of the research is to study PBMCS in Ethiopian Federal Roads, thereby contributing to effective implementation of the country‟s road maintenance program. The main objective is to study Performance based Maintenance contracting system for the current federal road maintenance practice in the country in reference with the current contracting system in place. The research design and methodology to be followed towards this end are discussed as follows.

3.2 Research design

Qualitative Research of explanatory type will be adopted in order to diagnose a situation, assess alternatives, and discover new ideas. The overall approach to be followed are; having established the basis of the research, necessary data will be collected, analyzed, and conclusions and recommendations will be made based on the findings. The methods of data collections employed for the research are case study, desk study, and interview. The case study and desk study were analyzed in relation to theoretical propositions, and the responses obtained from the interview were also be analyzed. The next sections discuss the tools used for data collection and method of analysis.

3.3 Data collection

3.3.1 Case study

In this study, the road maintenance contracts used in federal roads were chosen as one of the tools to find out the answer for the 1st research question, “Is the current road maintenance contractual practice implemented in the country satisfactory? The approach used to select samples/projects for the case study was Criterion-based sampling in which, a case that serves the real purpose and objectives of the research is selected. The criteria used for selecting projects are listed here under:

- The projects shall be administered by Federal Road Agency (ERA).
- All Projects shall be contracted under routine and periodic maintenance in the ten districts.
- The duration of the contract shall be one year (from July 2013 to June 2014).

Status of road conditions in 2013/2014 FY., contract price, contact length, cost overrun/under run and total birr consumed of all routine and periodic maintenance projects in the ten districts were the data extracted from the case studies.

3.3.2 Desk study

Desk study was chosen as one of the instruments to assess and obtain actual data about the practices road maintenance contracts from relevant studies, reports and documents.

3.3.3 Interview

Information for research questions was searched from key informants in order to deepen the findings of the case study and desk study. Purpose of the interview was to assess the practices and perceptions of key informants on road maintenance contracts and federal road maintenance practices in general.

The interview schedule shown in the Appendix consists of four main questions as enumerated from No. 2 to 4, Question 1 being inquiry about the informants‟ profile. The questions (2-4) focus on the following issues.

Question No.2 focused on the current road maintenance contractual practice implemented in Ethiopian federal roads. “What type of road maintenance contracting system do you use for federal road maintenance”, “Do you find the current contractual practice implemented in the country satisfactory?”, “If No, What are the major impediments of the current contractual practice?” were the questions raised for the informants. These questions were intended to achieve the first objective of the research.

Question No.3 was meant to study PBMCs for Ethiopian federal roads. “Do you use PBMCs for maintaining federal Road?”, “Do you think the current road maintenance industry is suffering from cost overrun/under run and poor condition of contracted road assets?” were some of the questions forwarded to the key informants. The questions were intended to answer the the first and second research objectives.

Question No.4 dealt with the major drawbacks in implementing PBMCs for the current maintenance industry in Ethiopia. The questions were intended to achieve the fourth objective of the research. Detail interview questions ad sample format is attached in the Annex-1.

3.4 Sample Size/Research population

The research population will be drawn from agencies involved in federal road maintenance projects. ERA, ERCC, Ethiopian Road Fund and others contractors (very few) who are involved in road maintenance. As much as possible attempts have been made so that the samples drawn from the population are representatives. Professionals include those reputed experts engaged in the road maintenance and were involved in it in the near past.

Based on the geographical locations Ethiopian Roads Authority has classified the countries road network in to five regional areas. These are:

1. Northern ERA Regional areas
    - Gonder District
    - Adigrat District
    - Debre Markos District
    - Combolcha District
2. Southern ERA Regional areas
    - Shashemene District
    - Sodo District
3. Eastern ERA Regional areas
    - Dire Dawa District
4. Western ERA Regional areas
    - Jimma District
    - Nekempte District
5. Central ERA Regional areas
    - Alemgena District

Figure 3.1: Geographical model

The researcher uses each district on the road network for the study, as each represent the entire population size.

3.5 Data Analysis

The case study and desk study were analyzed in relation to the theoretical propositions. The method used to analyze the interview data is descriptive statistics method. This method of analysis helps to analyze the responses in actual numbers.

All the data collected were organized and relevant answers were summarized in order to reach at meaningful conclusion. Secondary data were used as supplementary source of information.

4. RESULTS AND DISCUSSION

4.1 General Overview

This chapter deals with the analysis of the information‟s gathered from case study, desk study and interview, which includes analysis of contractual data for the ten road maintenance districts in the country, tendency of cost overrun versus contract amount, its extent, the status of the road conditions contracted, the type of contracts practiced and overview of performance based road maintenance contracting system for Ethiopian federal roads. The case study was conducted within the parties engaged in road maintenance i.e. ERA (client), Ethiopian Road fund Administration (Financer) and ERCC (Contractor). The documents referred during desk study include, progress reports, contract documents, Financial Reports and other related documents. Interviews were also conducted with key informants involved in road maintenance in order to deepen the findings of case study and desk study.

4.2 Case Study

In this study, the road maintenance contracts used in federal roads were chosen as one of the tools to find out the answer for the 1st research question, “Is the current road maintenance contractual practice implemented in the country satisfactory? The approach used to select samples/projects for the case study was Criterion-based sampling in which, a case that serves the real purpose and objectives of the research is selected. Thus, 10 districts under ERCC under contract to maintain federal roads were studied.

4.2.1 Adigirat Road Maintenance Project

Adigrat Road Maintenance Project is located in the Northern corridor of Ethiopia in Tigray Regional State. The Head Quarter of the Project is located at 903 Km from Addis Ababa in Adigrat Town. The road maintenance area is divided into four work executions. These are:

- Maichew Work Execution Team
- Adiabun Work Execution Team
- Shire Work Execution Team and
- Mekelle Work Execution Team.

Under all work execution teams there is 1090 km of asphalt road and 567 km of gravel road. Adigrat road maintenance district is connected at Waja with Combolcha road maintenance project, at Boya river and Humera with Gonder road maintenance project and at Zalambeassa with Eritrea.

The road network links the other parts of Ethiopia with the northern extremes of the country, facilitating the social, economic and political interactions of people with in the regional state and the country as a whole. It also links the vast Farmland Humera with the central part of the region. The network also facilitates the transportation of industrial and agricultural products to the other parts of Ethiopia, further enhancing access for tourism in the areas of Axum, Debre-Damo and and Yeha Temple. In 2013/14, fiscal year (FY) 707km of roads was under Routine Maintenance contract while the periodic maintenance contracts covers 53 km.

Table 4.1: Contractual Data for Routine Maintenance under Adigrat District

Basic Contractual Data for Routine Maintenance under Adigrat District											
No	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Adigrat Road maintenance Project)	Adigrat Road Network Management	July,2013	Taditional Unit Rate	15,600,000 ETB	3,120,000 ETB	707 km	365 Days

Table 4.2: Contractual Data for Periodic Maintenance under Adigrat District

Basic Contractual Data for Periodic Maintenance project under Adigrat District											
No	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Sekota Agbe	Road fund	Ethiopian Roads Authority	ERCC (Adigrat Road maintenance Project)	Nomy consulting PLC	July,2013	Taditional Unit Rate	8,000,000 ETB	1,600,000 ETB	20 km	365 Days
2	Maichew Betmera	Road fund	Ethiopian Roads Authority	ERCC (Adigrat Road maintenance Project)	Nomy consulting PLC	July,2013	Taditional Unit Rate	4,000,000 ET	800,000 ETB	15 km	365 Days
3	Mehoni Maichew	Road fund	Ethiopian Roads Authority	ERCC (Adigrat Road maintenance Project)	Nomy consulting PLC	July,2013	Taditional Unit Rate	5,100,000 ETB	1,020,000 ETB	18 km	365 Days

4.2.1.1 Overview of Road Maintenance Contracting Data and Road Conditions under Adigrat RMP

Routine Maintenance: Routine Maintenance contract price, status of road condition and cost overrun for road segments contracted under routine maintenance in 2013/2014 FY of Adigrat Road Maintenance Project.

Table 4.3: Routine Maintenance Contract Price and Road Condition under Adigrat District

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun Original Price	Original Contract Length	Executed Contract length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Routine Maintenance	15,600,000	9,268,000	24,868,000.00	59.41	707 km	707 km	76	14	10

***Periodic Maintenance*:** Periodic Maintenance contract price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY of Adigrat Road Maintenance Project.

Table 4.4: Basic Contractual Data and Status of road conditions for periodic maintenance under Adigrat RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun/ Original Price	Original Contract Length	Executed Contract length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Sekota Agbe	8,000,000	0	8,000,000.00	-	20 km	21 km	70	20	10
2	Maichew Betmera	4,000,000	10,000,000	14,000,000.00	100+	15 km	15 km	60	15	25
3	Mehoni Maichew	5,100,000	951,000	6,051,000.00	18.65	18 km	18 km	80	10	10
	Total	17,100,000	10,951,000	28,051,000	64.04	53 km	54 km			

Table 4.5 below shows Adigrat Road Maintenance Project overall contacting Price, Cost overrun and Status of Road Condition in 2013/2014, FY for both routine and periodic maintenance projects.

Table 4.5: Adigrat Road Maintenance Project Contractual price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun/ Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Adigrat RMP	32,700,000	20,219,000	52,919,000.00	61.83	76	14	10

4.2.2 Shashemene Road Maintenance Project

Shashemene Road maintenance is located in the southern parts of the country and is composed of Oromia Region (North, West and East), Southern Region (South) and Somalia Region (South Eastern). Shashemene project is located 246 km from Addis Ababa at Shashemene town. The terrain of the project is mountainous (bale mountains) at Dodola and Robe work executions team and plane for the rest.

The district is composed of six maintenance sections. These are:

- Alaba-Shashemene-H/Mariam Execution Team
- Asela-Bokoji-Sebsbewasha Execution Team
- K/Mengist section Execution Team
- Robe section Execution Team
- Robe-Goro-Ginner Execution Team and,
- Dilla Execution Team.

The district covers a total network length of 2716 km of which 593 km is asphalt and 2123 km Gravel road. The road network links parts of Northern, Eastern and Southern Oromia regions acting as the only means of for transportation of goods to the other areas of Ethiopia. Bale Mountains, National Park, Dinsho National Park and Soph-omore cave can be accessed through this network. The southern part of the network also leads to Kenya. In 2013/2014 Fiscal year 1035km of roads was under Routine Maintenance contract while the periodic maintenance contracts cover 138 km.

Table 4.6: Contractual Data for Routine Maintenance under Shashemene RMP

Basic Contractual Data for Routine Maintenance under Shashemene District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Shashemene Road maintenance Project)	Shashemene Road Network Management	July,2013	Taditional Unit Rate	22,000,000 ETB	4,400,000 ETB	1035 km	365 Days

Table 4.7: Contractual Data for Periodic Maintenance Projects under Shashemene District

No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Bidre Bitata	Road fund	Ethiopian Roads Authority	ERCC (Shashemene Road maintenance Project)	Fine Engineers Plc	July,2013	Taditional Unit Rate	6,347,826.09 ETB	1,269,565 ETB	25 km	365 Days
2	Goba Dollemena	Road fund	Ethiopian Roads Authority	ERCC (Shashemene Road maintenance Project)	Shashemene Road Network Management	July,2013	Taditional Unit Rate	8.800,000 ETB	1,760,000 ETB	25 km	365 Days
3	Bulbula Algae	Road fund	Ethiopian Roads Authority	ERCC (Shashemene Road maintenance Project)	Shashemene Road Network Management	July,2013	Taditional Unit Rate	7,500,000 ETB	1,500,000 ETB	25 km	365 Days
4	Apposto-Yirgalem	Road fund	Ethiopian Roads Authority	ERCC (Shashemene Road maintenance Project)	Shashemene Road Network Management	July,2014	Taditional Unit Rate	3,300,000 ETB	660,000 ETB	8 km	365 Days
5	H/mariam-Burji	Road fund	Ethiopian Roads Authority	ERCC (Shashemene Road maintenance Project)	Shashemene Road Network Management	July,2014	Taditional Unit Rate	8,300,000 ETB	1,660,000 ETB	30 km	365 Days

4.2.2.1 Overview of Road Maintenance Contracting Data and Road Condition under Shashemene RMP

Routine Maintenance: Routine Maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FY of Shashemene road Maintenance Project.

Table 4.8: Routine Maintenance Contract price and status of the road under Shashemene RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Routine Maintenance	22,000,000	4,727,470	26,727,470.00	21.49	1035 km	1035 km	62	22	16

***Periodic Maintenance*:** Periodic maintenance contract price, status of road condition and cost overrun for road segments contracted under periodic maintenance in 2013/2014 FY of Shashemene Road Maintenance Project.

Table 4.9: Basic Contractual Data and Status of road conditions for periodic maintenance projects under Shashemene RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Bidre Bitata	6,347,826	5,177,485	11,525,311.00	81.56	25 km	25 km	50	50	
2	Goba Dollemena	8,800,000	8,440,928	17,240,928.00	95.92	25 km	25 km	35	40	25
3	Bulbula Algae	7,500,000	3,491,311	10,991,311.00	46.55	25 km	29 km	90	10	
4	Apposto-Yirgalem	3,300,000	-3,300,000	-	(100.00)	8 km		70	20	
5	H/mariam-Burji	8,300,000	-1,404,245	6,895,754.68	(16.92)	30 km	30 km	80	20	
	Total	34,247,826	12,405,479	46,653,305	36.22	113 km	109 km			

Table 4.10 below shows Shashemene Road Maintenance Project overall contacting Price, Cost overrun and Status of Road Condition in 2013/2014 FY for both routine and periodic maintenance projects.

Table 4.10: Shashemene Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Shashemene RMP	56,247,826	17,132,949	73,380,774.68	30.46	62	22	16

4.2.3 Combolcha Road Maintenance Project

Combolcha road maintenance is located in Amhara Region, at Combolcha town about 375 Km North East of Addis Ababa. In the region where the road network of the project is located, the terrain is composed of almost all classes; flat, rolling, hilly and mountainous. The network is very essential for socio economic development of the region.it facilitates the measure trade activity of the country since it has the road segment linking Ethiopia Djibouti port and those off the region for exchange of commodities, business and marketing.

There are five sections under the Combolcha road maintenance project these are:

- Combolicha work Execution Team
- Woldia work Execution Team
- Dithoto work Execution Team
- Tenta work Execution Team and
- Gashena work Execution Team.

The district covers a total network length of 2124 km of which 119 km is asphalt and 2005 km Gravel road. In 2013/2014, FY 840km of roads was under Routine Maintenance contract while the three selected periodic maintenance contracts covers 70km.

Table 4.11 below shows Basic Contractual Data for Routine and selected Periodic Maintenance projects under Combolcha Road Maintenance Projects.

Table 4.11: Contractual Data for Routine Maintenance under Combolcha RMP

Basic Contractual Data for Routine Maintenance under combolicha District											
No.	Project	Source (Fund)	Client	Contractor	Consultant	commencement Date	Type of Contract	Original Contract Price	Advance Payment	Contract Length	Completion Date
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Combolcha Road maintenance Project)	Combolcha Road Network Management	July,2013	Taditional Unit Rate	14,100,000 ETB	2,820,000 ETB	840 km	365 Days

Table 4.12: Contractual Data for Periodic Maintenance under Combolcha RMP

Basic Contractual Data for Periodic Maintenance project under Combolcha District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Bito River Akesta	Road fund	Ethiopian Roads Authority	ERCC (Combolcha Road maintenance Project)	Combolcha Road Network Management	July,2013	Taditional Unit Rate	7,300,000 ETB	1,460,000 ETB	25 km	365 Days
2	Guguftu Dogolo	Road fund	Ethiopian Roads Authority	ERCC (Combolcha Road maintenance Project)	Segenet Engineering Plc.	July,2013	Taditional Unit Rate	7,600,000 ETB	1,520,000 ETB	20 km	365 Days
3	Lalibela Kobo	Road fund	Ethiopian Roads Authority	ERCC (Combolcha Road maintenance Project)	Segenet Engineering Plc.	July,2013	Taditional Unit Rate	11,286,253.53 ETB	2,257,250.71 ETB	20 km	365 Days
4	Degolo-Beto River	Road fund	Ethiopian Roads Authority	ERCC (Combolcha Road maintenance Project)	Combolcha Road Network Management	July,2013	Taditional Unit Rate	10,050,000 ETB	2,010,000 ETB	30 km	365 Days

4.2.3.1 Overview of Road Maintenance Contracting Data and Road Condition under Combolcha RMP

Routine Maintenance: Routine Maintenance contract price, status of road condition and cost overrun for road segments contracted under routine maintenance in 2013/2014 FY of Combolcha road Maintenance Project.

Table 4.13: Routine Maintenance Contract price and status of the road under Combolcha RMP

No.	**Project**	**Original Contract Price**	**Cost Over Run**	**Total Birr Consumed 2013/2014 FY.**	**%cost Overrun / Original Price**	**Original Contract Length**	**Executed Contract Length**	**Status of the Road condition (%) 2013/2014 FY.**		
								Good	**Fair**	**Poor**
1	Routine Maintenance	14,100,000	15,995,401	30,095,401.00	113.44	840 km	840 km	50	24	26

Periodic Maintenance : Periodic maintenance contract price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY of Combolcha road Maintenance Project.

Table 4.14: Basic Contractual Data and Status of road conditions for periodic maintenance under Combolcha RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Beto River Akesta	7,300,000	105,140	7,405,140.00	1.44	25 km	25 km		60	40
2	Gugufto Dogolo	7,600,000	0	7,600,000.00	-	20 km	21 km		27.5	72.5
3	Lalibela Kobo	11,286,254	713,746	12,000,000.00	6.32	20 km	27 km		27.5	72.5
4	Degolo-Beto River	10,050,000	0	10,050,000.00	-	30 km	30 km		40	60
	Total	36,236,254	818,886	37,055,140.00	2.26	95 km	103 km			

Table 4.15 below shows Combolcha Road Maintenance Project overall contacting Price, Cost overrun and Status of Road Condition in 2013/2014 FY for both routine and periodic maintenance projects.

Table 4.15: Combolcha Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Combolcha RMP	50,336,254	16,814,287	67,150,541	33.40	50	24	26

4.2.4 Dire Dawa Road Maintenance project

Dire Dawa Road Maintenance Project is located at Dire Dawa Town, 515 km from Addis Ababa. The road network under Dire Dawa connects Afar, Somalia, Oromia and Harari Regions. The network stretches from flat terrain and arid area in the afar and Somalia region to the very rugged mountainous terrain in the middle and western Hararge in the Oromia Region. It plays a great role in the socio economic development of the regions as well as facilitating the mobilization of people and goods from one region to the other.

Dire Dawa road maintenance project has five operational work execution tems under it. These are:

- Awash Dengego Work Execution Team
- Dire Dawa-Harar-Jijiga Work Execution Team
- Dengego work Execution Team
- Albereket Shek Husen Work Execution Team and,
- Jijiga Work Execution Team.

The project is composed of 1393 Km paved and 1467 Km Unpaved roads. In 2013/2014 Fiscal year 1093 km of roads was under Routine Maintenance contract while the periodic maintenance contracts covers 80km.

Table 4.16: Contractual Data for Routine Maintenance under Dire Dawa District

Basic Contractual Data for Routine Maintenance under Dire Dawa District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Dire Dawa Road Network Management	July,2013	Taditional Unit Rate	20,600,000 ETB	4,120,000 ETB	1093 km	365 Days

Table 4.17: Contractual Data for Periodic Maintenance under Dire Dawa District

Basic Contaractual Data for Periodic Maintenance under Dire Dawa District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Dire Dawa Dewelle	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Dire Dawa Road Network Management	July,2013	Taditional Unit Rate	25,500,000 ETB	5,000,000 ETB	50 km	365 Days
2	Melka Jebdu Hurso	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Dire Dawa Road Network Management	July,2013	Taditional Unit Rate	6,700,000 ETB	1,340,000 ETB	17 km	365 Days
3	Kobo Deder	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Dire Dawa Road Network Management	July,2013	Taditional Unit Rate	5,200,000 ETB	1,040,000 ETB	13 km	365 Days

4.2.4.1 Overview of Road Maintenance Contracting Data and Road Condition under Dire Dawa RMP

***Routine Maintenance*:** Routine maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FY of Dire Dawa road Maintenance Project.

Table 4.18: Routine Maintenance Contract price and status of the road under Dire Dawa RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Routine Maintenance	20,600,000	6,276,786	26,876,786.42	30.47	1093 km	1093 km	59	23	18

Periodic Maintenance :Routine maintenance contract price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY under Dire Dawa road Maintenance Project.

Table 4.19: Basic Contractual Data and Status of road conditions for periodic maintenance under Dire Dawa RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Dire Dwa Dewelle	25,000,000	17,002,128	42,002,128.18	68.01	50 km	50 km			
2	Melka Jebdu-Hurso	6,800,000	-401,077	6,398,923.19	(5.90)	17 km	14 km	60	30	10
3	Koba Deder	5,200,000	-320,763	4,879,236.61	(6.17)	13 km	19 km	60	30	10
Total		37,000,000	16,280,288	53,280,288	44.00	80 km	83 km			

Table 4.20 below shows Dire Dawa Road Maintenance Project overall contacting Price, Cost overrun and Status of Road Condition in 2013/2014, FY for both routine and periodic maintenance projects.

Table 4.20: Dire Dawa Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Dire Dawa Project	57,600,000	22,557,074	80,157,074.40	39.16	59	23	18

4.2.5 Debre-Markos Road Maintenance Project

Debre-Markos Road Maintenance Project, which undertakes maintenance activities within Amhara and Benishangul Gumuz eight regions in the northwestern part of Ethiopia, is located at 300 km from Addis Ababa. The terrain can be taken as flat, rolling and mountainous. The project road network is divided into 27 road segments, classified as trunk and link roads. The district performs planned maintenance activities through four work execution, namely;

- Dejen Work Execution Team
- Bure Work Execution Team
- Bahirdar Work Execution Team and
- Chagnie Work Execution Team.

The Project covers a total network length of 1527 km of which 335 km is asphalt and 1172 km Gravel road.

In 2013/2014 Fiscal year 1093km of roads was under Routine Maintenance contract while the periodic maintenance contracts covers 80km.Table 4.21 below shows Basic Contractual Data for Routine and Periodic Maintenance Works under D/Markos Road Maintenance Project.

Table 4.21: Contractual Data for Routine Maintenance under D/Markos RMP

Basic Contractual Data for Routine Maintenance under Debre Markos District											
No.	Project	Source (Fund)	Client	Contractor	Consultant	commencement Date	Type of Contract	Original Contract Price	Advance Payment	Contract Length	Completion Date
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Debre Markos Road Network Management	July,2013	Taditional Unit Rate	35,000,000ETB	7,000,000 ETB	1273 km	365 Days

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Table 4.22: Contractual Data for Periodic Maintenance under D/Markos RMP

Basic Contractual Data for Periodic Maintenance under Debre Markos District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Powe Juncttion Guba	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Debre Markos Road Network Management	July,2013	Taditional Unit Rate	10,000,000ETB	2,000,000 ETB	30 km	365 Days
2	D/Markos Rob Gebeya	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Debre Markos Road Network Management	July,2013	Taditional Unit Rate	8,300,000 ETB	1,660,000ETB	25 km	365 Days
3	D/Markos Bitchena	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Debre Markos Road Network Management	July,2013	Taditional Unit Rate	10,296,396 ETB	1,660,000ETB	25 km	365 Days
4	Debate-junction-Debate	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Debre Markos Road Network Management	July,2013	Taditional Unit Rate	7,000,000 ETB	1,400,000 ETB	25 km	365 Days
5	Felegeberhan-B/Dar	Road fund	Ethiopian Roads Authority	ERCC (Dire Dawa Road maintenance Project)	Debre Markos Road Network Management	July,2013	Taditional Unit Rate	8,000,000 ETB	1,600,000ETB	30 km	365 Days

4.2.5.1 Overview of Road Maintenance Contracting Data and Road Condition under D/Markos RMP

Routine Maintenance: Routine maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FY of D/Markos road Maintenance Project.

Table 4.23: Routine Maintenance Contract price and status of the road under D/Markos RMP

No.	**Project**	**Original Contract Price**	**Cost Over Run**	**Total Birr Consumed 2013/2014 FY.**	**%cost Overrun / Original Price**	**Original Contract Length**	**Executed Contract Length**	**Status of the Road condition (%) 2013/2014 FY.**		
								Good	**Fair**	**Poor**
1	Routine Maintenance	35,000,000	-2,047,560	32,952,440	(5.85)	1278 km	1071km	35	26	39

Periodic Maintenance :Periodic maintenance contract price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY of D/Markos road maintenance Project.

Table 4.24: Basic Contractual Data and Status of road conditions for periodic maintenance under D/Markos RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Powe junction Guba	10,000,000	7,300,000	17,300,000	73.00	30 km	30 km	10	20	70
2	D/Markos Rob Gebeya	8,300,000	-1,759,148	6,540,852	(21.19)	25 km	25 km	30	30	40
3	D/Markos Botchena	7,200,000	3,096,396	10,296,396	43.01	25 km	33 km	30	30	40
4	Debate-junction-Debate	7,000,000	0	7,000,000	-	25 km	25 km	10	20	70
5	Felegeberhan-B/Dar	8,000,000	-2,375,167	5,624,833	(29.69)	30 km	30 km	10	40	50
Total		32,200,000	14,562,081	46,762,081	45.22	135 km	142 km			

Table 4.25 below shows D/Markos Road Maintenance Project overall contacting Price, Cost overrun and Status of Road Condition in 2013/2014, FY for both routine and periodic maintenance projects.

Table 4.25: D/Markos Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	D/Markos Project	67,200,000	12,514,521	79,714,521	18.62	35	26	39

4.2.6 Sodo Road Maintenance Project

Sodo Road Maintenance Project is located in the southern part of the country, at Wolaita-Sodo town, 330 km south west of Addis Ababa. In the region where the road network is located, the terrain is composed of almost all classes; flat, rolling, hilly and mountainous.

There are four road maintenance work executions (sections) under the management of sodo road maintenance district. These are:

- Soda Work Execution Team
- Konso Work Execution Team
- Turmi Work Execution Team and
- Mega Work Execution Team.

The Project covers a total network length of 1966 km of which 777 km is asphalt and 1189 km Gravel road. Important resources for the region for socio economic development include cash crops like coffee, fruits, teff and butter. The road network facilitates the transportation of people within the region and those off the region for exchange of commodities, business and marketing.

In 2013/2014, FY 921 km of roads was under Routine Maintenance contract while the periodic maintenance contracts covers 60 km. Table 4.26 below shows Basic Contractual Data for Routine and Periodic Maintenance Works under D/Markos Road Maintenance Project.

Table 4.26: Contractual Data for Routine Maintenance under Sodo RMP

Basic Contractual Data for Routine Maintenance under Sodo District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Sodo Road maintenance Project)	Sodo Road Network Management	July,2013	Taditional Unit Rate	24,700,000 ETB	4,940,000 ETB	921 km	365 Days

Table 4.27: Contractual Data for Periodic Maintenance under Sodo RMP

Basic Contractual Data for Periodic Maintenance under Sodo District											
No.	**project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Sodo Areka	Road fund	Ethiopian Roads Authority	ERCC (Sodo Road maintenance Project)	Fine Engineers Plc	July,2013	Taditional Unit Rate	6,500,000 ETB	1,300,000 ETB	10 km	365 Days
2	Wachile Bulbule	Road fund	Ethiopian Roads Authority	ERCC (Sodo Road maintenance Project)	Sodo Road Network Management	July,2013	Taditional Unit Rate	7,000,000 ETB	1,400,000 ETB	25 km	365 Days
3	Konso Burji	Road fund	Ethiopian Roads Authority	ERCC (Sodo Road maintenance Project)	Sodo Road Network Management	July,2013	Taditional Unit Rate	7,500,000 ETB	1,500,000 ETB	25 km	365 Days

4.2.6.1 Overview of Road Maintenance Contracting Data and Road Condition under Sodo RMP

***Routine Maintenance*:** Routine maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FY of Sodo road maintenance Project.

Table 4.28: Routine Maintenance Contract price and status of the road under Sodo RMP

No.	**Project**	**Original Contract Price**	**Cost Over Run**	**Total Birr Consumed 2013/2014 FY.**	**%cost Overrun / Original Price**	**Original Contract Length**	**Executed Contract Length**	**Status of the Road condition (%) 2013/2014 FY.**		
								Good	**Fair**	**Poor**
1	Routine Maintenance	24,700,000	15,596,825	40,296,825	63.15	921 km	921 km	27	48	24

***Periodic Maintenance*:** Periodic maintenance contract price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY of Sodo road Maintenance Project.

Table 4.29: Periodic Maintenance Contract price and status of the road under Sodo RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Sodo Areka	6,500,000	1,000,000	7,500,000	15.38	10 km	4 km			100
2	Wachile Bulbule	7,000,000	1,908,085	8,908,085	27.26	25 km	25 km			100
3	Konso Burji	7,500,000	1,015,377	8,515,377	13.54	25 km	25 km			100
	Total	21,000,000	3,923,462	24,923,462	18.68	60 km	54 km			

Table 4.30: Sodo Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Sodo Project	45,700,000	19,520,287	65,220,287	42.71	27	48	24

4.2.7 Jimma Road Maintenance Project

Jimma Road maintenance project is responsible for the maintenance of federal roads found in south west Ethiopia namely Oromia, SNNP and Gambella Regional states. Currently, the total network of the road maintenance project covers 2562 km of road, out of this 582 km is asphalt and the remaining 1980 km being gravel. Most of the existing condition of the road is highly deteriorated due to high traffic, heavy rainfall prevailing in the network area and absence of timely maintenance intervention.

There are five work execution teams under Jimma road maintenance project. These are:

- Jimma Work Execution Team
- Metu Work Execution Team
- Teppi Work Execution Team

- Chidda Work Execution Team and
- Gambella work Execution Team.

The road network traverse through coffee, and the maintenance of the road plays important role in terms of social ,economical and political aspects of the local regions in particular and the country as a whole. In 2013/2014, FY 1297 km of roads was under Routine Maintenance contract while the periodic maintenance contracts covers 65 km.

Table 4.31: Contractual Data for Routine Maintenance under Jimma RMP

Project	Source (Fund)	Client	Contractor	Consultant	commencement Date	Type of Contract	Original Contract Price	Advance Payment	Contract Length	Completion Date
Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Jimma Road maintenance Project)	Jimma Road Network Management	July,2013	Taditional Unit Rate	60,000,000 ETB	12,000,000 ETB	1297 km	365 Days

Table 4.32: Contractual Data for Periodic Maintenance under Jimma RMP

Basic Contractual Data for Periodic Maintenance under Jimma District										
No.	project	Source (Fund)	Client	Contractor	Consultant	commencement Date	Type of Contract	Original Contract	Advance Payment	Contract Length	Completion Date
1	Jimma Agaro	Road fund	Ethiopian Roads Authority	ERCC (Jimma Road maintenance Project)	Jimma Road Network Management	July,2013	Taditional Unit Rate	10,000,000 ETB	2,000,000 ETB	15 km	365 Days
2	Gimbo Gojebe	Road fund	Ethiopian Roads Authority	ERCC (Jimma Road maintenance Project)	Jimma Road Network Management	July,2013	Taditional Unit Rate	8,000,000 ETB	1,600,000 ETB	25 km	365 Days
3	Limmu Junction Kosse	Road fund	Ethiopian Roads Authority	ERCC (Jimma Road maintenance Project)	Jimma Road Network Management	July,2013	Taditional Unit Rate	8,000,000 ETB	1,600,000 ETB	25 km	365 Days

4.2.7.1 Overview of Road Maintenance Contracting Data and Road Condition under Jimma RMP

Routine Maintenance: Routine maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FY of Jimma road maintenance Project.

Table 4.33: Routine Maintenance Contract price and status of the road under Jimma RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Routine Maintenance	60,000,000	-11,269,092	48,730,908	(18.78)	1297 km	955 km	27	27	46

Periodic Maintenance :Periodic maintenance contract price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY of Jimma road maintenance Project.

Table 4.34: Periodic Maintenance Contract price and status of the road under Jimma RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Jimma Agaro	10,000,000	-9,614,627	385,373	(96.15)	15 km	12 km	10	20	70
2	Gimbo Gojebe	8,000,000	306,393	8,306,393	3.83	25 km	28 km		20	80
3	Limmu Junction Kosse	8,000,000	-7,376,763	623,237	(92.21)	25 km	5 km	10	20	70
	Total	26,000,000	-16,684,997	9,315,003	(64.17)	65 km	45 km			

Table 4.35: Jimma Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Jimma RMP	86,000,000	-27,954,089	58,045,911	(32.50)	27	27	46

4.2.8 Gonder Road Maintenance Project

Gonder Road Maintenance Project is one of the ten road Maintenance projects in the country undertaking routine and periodic maintenance activities in the north and northwestern part of the country. The road network lies partly on Amhara and Partly on Tigray regional states. The head quarter of the maintenance project is located at Historic city of Gonder Town about 750 km away from Addis Ababa.

The road network passes through mountainous terrain of Limalimo rough ad rugged area closer to Semien Mountain; the plateau of Wagera and Fogera and low land areas of Tach Armacheho and Metema. The road network has an access to Port Sudan, Djibouti, Lake Tana and vast agricultural fields of Humera and Maikadra.

Gonder is a home for Fassiladas castle, island of Lake Tana, Nile Fall and Semien Mountains, which have a great attraction for tourists and accessed by using the road network under the district. The network plays a vital role in boosting trade, tourism and Transportation. The RMP is responsible for the maintenance of 1449 km of roads, out of which 688 km is gravel surfaced and the rest 761 km is Asphalt.

Gonder has three work executions under taking maintenance activities on 25 road segments. These are:

- Debre Tabor Work Execution Team
- Debark Work Execution Team and
- Azezo Work Execution

In 2013/2014, FY 1155 km of roads was under Routine Maintenance contract while the three selected periodic maintenance contracts cover 150 km. Table4.36 below shows Basic Contractual Data for Routine and Periodic Maintenance Works under Gonder Road Maintenance Project.

Table 4.36: Contractual Data for Routine Maintenance under Gonder RMP

Basic Contaractual Data for Routine Maintenance under Jimma District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Gonder Road maintenance Project)	Gonder Road Network Management	July,2013	Taditional Unit Rate	25,200,000 ETB	5,040,000 ETB	1155 km	365 Days

Table 4.37: Contractual Data for Periodic Maintenance under Gonder RMP

Basic Contractual Data for Periodic Maintenance under Gonder District											
No.	**project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Shehdei Gelgo	Road fund	Ethiopian Roads Authority	ERCC (Gonder Road maintenance Project)	Gonder Road Network Management	July,2013	Taditional Unit Rate	6,800,000 ETB	1,360,000 ETB	35 km	365 Days
2	Addis Zemen Abnet	Road fund	Ethiopian Roads Authority	ERCC (Gonder Road maintenance Project)	Gonder Road Network Management	July,2013	Taditional Unit Rate	7,300,000ETB	1,460,000 ETB	30 km	365 Days
3	Hamusit Aste	Road fund	Ethiopian Roads Authority	ERCC (Gonder Road maintenance Project)	Gonder Road Network Management	July,2013	Taditional Unit Rate	7,500,000 ETB	1,500,000 ETB	35 km	365 Days
4	Delgi Chwahit	Road fund	Ethiopian Roads Authority	ERCC (Gonder Road maintenance Project)	Gonder Road Network Management	July,2013	Taditional Unit Rate	6,700,000 ETB	1,340,000 ETB	25 km	365 Days
5	Gasay - Semada	Road fund	Ethiopian Roads Authority	ERCC (Gonder Road maintenance Project)	Gonder Road Network Management	July,2013	Taditional Unit Rate	8,000,000 ETB	1,600,000 ETB	25 km	365 Days

4.2.8.1 Overview of Road Maintenance Contracting Data and Road Condition under Gonder RMP

Routine Maintenance: Routine maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FY of Gonder road maintenance Project.

Table 4.38: Routine Maintenance Contract price and status of the road under Gonder RMP

No.	**Project**	**Original Contract Price**	**Cost Over Run**	**Total Birr Consumed 2013/2014 FY.**	**%cost Overrun / Original Price**	**Original Contract Length**	**Executed Contract Length**	**Status of the Road condition (%) 2013/2014 FY.**		
								Good	**Fair**	**Poor**
1	Routine Maintenance	25,200,000	-7,231,077	17,968,923	(28.69)	1155 km	841 km	62	23	15

Periodic Maintenance :Periodic Maintenance price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY of Gonder road maintenance Project.

Table 4.39: Periodic Maintenance Contract price and status of the road under Gonder RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Shehdei Gelgo	6,800,000	5,807,903	12,607,903	85.41	35 km	35 km	60	20	20
2	Addis Zemen Abnet	7,300,000	1,143,091	8,443,091	15.66	30 km	20 km	50	50	
3	Hamusit Aste	7,500,000	2,752,571	10,252,571	36.70	35 km	35 km		30	70
4	Delgi Chwahit	6,700,000	3,486,101	10,186,101	52.03	25 km	25 km		30	70
5	Gasay - Semada	8,000,000	-13,436	7,986,564	(0.17)	25 km	25 km		30	70
	Total	36,300,000	13,176,230	49,476,230	36.30	160 km	140 km			

Table 4.40: Gonder Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Gonder RMP	61,500,000	5,945,153	67,445,153	9.67	62	23	15

4.2.9 Nekempte Road Maintenance Project

Nekempte road maintenance project is located in western part of the country, at Nekempte Town, 330 km away from Addis Ababa. Most of the network passes through mountainous area, anticipating heavy rainfall most of the time. The road network serves the society of the region by facilitating transportation in parts of Oromia, Gambela, Amhara and Benishangul Region. It provides access for health centers further enhancing socioeconomic development of the country. The area is well known for coffee, marble stone and „selit" and the road network helps to transport these products to the various parts of the country.

The road network covers 1785 km of road out of which 547 km is paved and the remaining 1268 km is gravel. The road maintenance project has five work execution teams undertaking maintenance activities. These are:

- Bako work Execution Team
- Nedjo Work Execution Team
- Assosa Work Execution Team
- Nekempte Work Execution Team and
- Gimbi Work Execution Team.

In 2013/2014 Fiscal year 1035 km of roads was under Routine Maintenance contract while the three selected periodic maintenance contracts covers 67 km. Table 4.41 below shows Basic Contractual Data for Routine and Periodic Maintenance Works under Nekempte Road Maintenance Project.

Table 4.41: Contractual Data for Routine Maintenance under Nekempte RMP

Basic Contractual Data for Routine Maintenance under Nekempte District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Nekempte Road maintenance Project)	Nekempte Road Network Management	July,2013	Taditional Unit Rate	21,600,000 ETB	4,320,000 ETB	1035 km	365 Days

Table 4.42: Contractual Data for Periodic Maintenance under Nekempte RMP

Basic Contractual Data for Periodic Maintenance under Nekempte District											
No.	**project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Gedo Fincha	Road fund	Ethiopian Roads Authority	ERCC (Nekempte Road maintenance Project)	Nekempte Road Network Management	July,2013	Taditional Unit Rate	6,800,000 ETB	1,360,000 ETB	17 km	365 Days
2	Shambu Agemsa	Road fund	Ethiopian Roads Authority	ERCC (Nekempte Road maintenance Project)	Nekempte Road Network Management	July,2013	Taditional Unit Rate	7,800,000 ETB	1,560,000 ETB	25 km	365 Days
3	Uke Gutin Gida	Road fund	Ethiopian Roads Authority	ERCC (Nekempte Road maintenance Project)	Nekempte Road Network Management	July,2013	Taditional Unit Rate	7,600,000 ETB	1,520,000 ETB	25 km	365 Days

4.2.9.1 Overview of Road Maintenance Contracting Data and Road Condition under Nekempte RMP

Routine Maintenance: Routine maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FYof Nekempte road Maintenance Project.

Table 4.43: Routine Maintenance Contract price and status of the road under Nekempte RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Routine Maintenance	21,600,000	25,692,447	47,292,447	118.95	1035 km	1035 km	39	56	5

Periodic Maintenance :Periodic maintenance contract price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014 FY of Nekempte road Maintenance Project.

Table 4.44: Periodic Maintenance Contract price and status of the road under Nekempte RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Gedo Fincha	6,800,000	1,707,129	8,507,129	25.10	17 km	17 km		100	
2	Shambu Agemsa	7,800,000	3,597,310	11,397,310	46.12	25 km	36 km		100	
3	Uke Gutin Gida	7,600,000	2,354,959	9,954,959	30.99	25 km	25 km		100	
Total		22,200,000	7,659,398	29,859,398	34.50	67 km	77 km			

Table 4.45: Nekempte Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Nekempte RMP	43,800,000	33,351,845	77,151,845	76.15	39	56	5

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4.2.10 Alemgena Road Maintenance Project

Alemgena Road Maintenance project is one of the ten road maintenance Projects of ERCC responsible for maintaining federal roads connecting Oromia, Amhara and Southern People regional states. The road network projects into five major outlets from the capital city of Addis Ababa. The rod is of high economic importance used entrance of agricultural and industrial products distributed to people living in the city and a exit for export items through Djibouti port. The Road Network compromises 1601 km of Asphalt and 2184 km of gravel road. Alemgena road maintenance project consists six work execution teams performing maintenance activities. These are:

- Butajira Work Execution Team
- Woliso Work Execution Team
- Ambo Work Execution Team
- Huruta Work Execution Team
- Debre Birhan Work Execution Team and
- Robit Work execution Team.

In 2013/2014, FY 1700 km of roads was under Routine Maintenance contract while the three selected periodic maintenance contracts cover 85 km. Table below shows Basic Contractual Data for Routine and Periodic Maintenance Works under Alemgena Road Maintenance Project.

Table 4.46: Contractual Data for Periodic Maintenance under Alemgena RMP

Basic Contractual Data for Periodic Maintenance under Alemgena District											
No.	**project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Ambo Gedo	Road fund	Ethiopian Roads Authority	ERCC (Alemgena Road maintenance Project)	Alemgena Road Network Management	July,2013	Taditional Unit Rate	10,500,000 ETB	2,100,000 ETB	30 km	365 Days
2	Alem ketema Dogolo	Road fund	Ethiopian Roads Authority	ERCC (Alemgena Road maintenance Project)	Alemgena Road Network Management	July,2013	Taditional Unit Rate	10,000,000 ETB	2,000,000 ETB	25 km	365 Days
3	Meki Dugdi Kella	Road fund	Ethiopian Roads Authority	ERCC (Alemgena Road maintenance Project)	Alemgena Road Network Management	July,2013	Taditional Unit Rate	6,200,000 ETB	1,240,000 ETB	20 km	365 Days
4	Comando-Fitche	Road fund	Ethiopian Roads Authority	ERCC (Alemgena Road maintenance Project)	Alemgena Road Network Management	July,2013	Taditional Unit Rate	4,000,000 ETB	800,000 ETB	7 km	365 Days
5	D/birhan-Jihur	Road fund	Ethiopian Roads Authority	ERCC (Alemgena Road maintenance Project)	Alemgena Road Network Management	July,2013	Taditional Unit Rate	8,900,000 ETB	1,780,000 ETB	25 km	365 Days

Table 4.47: Contractual Data for Routine Maintenance under Alemgena RMP

Basic Contractual Data for Routine Maintenance under Alemgena District											
No.	**Project**	**Source (Fund)**	**Client**	**Contractor**	**Consultant**	**commencement Date**	**Type of Contract**	**Original Contract Price**	**Advance Payment**	**Contract Length**	**Completion Date**
1	Routine Maintenance	Road fund	Ethiopian Roads Authority	ERCC (Alemgena Road maintenance Project)	Alemgena Road Network Management	July,2013	Taditional Unit Rate	62,000,000 ETB	12,400,000 ETB	1700 km	365 Days

4.2.10.1 Overview of Road Maintenance Contracting Data and Road Condition under Alemgena RMP

Routine Maintenance: Routine Maintenance contract price, status of road condition and cost overrun for road segments contracted under Routine Maintenance in 2013/2014 FY under Alemgena road Maintenance Project.

Table 4.48: Routine Maintenance Contract price and status of the road under Alemgena RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Routine Maintenance	62,000,000	-26,690,203	35,309,797	(43.05)	1700 km	1700 km	54	23	23

Periodic Maintenance :Periodic maintenance contrat price, status of road condition and cost overrun for road segments contracted under Periodic Maintenance in 2013/2014, FY under Alemgena road Maintenance Project.

Table 4.49: Periodic Maintenance Contract price and status of the road under Alemgena RMP

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014 FY.	%cost Overrun / Original Price	Original Contract Length	Executed Contract Length	Status of the Road condition (%) 2013/2014 FY.		
								Good	Fair	Poor
1	Ambo Gedo	10,500,000	-7,277,140	3,222,860	(69.31)	30 km	7 km	40	30	30
2	Alem ketema Dogolo	10,000,000	1,220,146	11,220,146	12.20	25 km	25 km	50	30	20
3	Meki Dugdi Kella	6,200,000	2,971,426	9,171,426	47.93	20 km	23 km	40	25	35
4	Comando-Fitche	4,000,000	-3,747,068	252,932	(93.68)	7 km	0.5 km	45	25	30
5	D/birhan-Jihur	8,900,000	844,899	9,744,899	9.49	25 km	27 km	60	25	15
	Total	39,600,000	-5,987,737	33,612,263	(15.12)	107 km	82.5 km			

Table 4.50: Alemgena Road Maintenance Project Contract price and Status of the road

No.	Project	Original Contract Price	Cost Over Run	Total Birr Consumed 2013/2014	%cost Overrun / Original	Status of the Road condition (%) 2013/2014 FY.		
						Good	Fair	Poor
1	Alemgena RMP	101,600,000	-32,677,940	68,922,060	(32.16)	54	23	23

*all data for the above case studies is obtained from ERCC(Road Maintenance projects progress report and Financial Accomplishment) and ERA road network condition survey.

4.2.11 Findings of the case study

The following key findings are obtained from case studies:

- In accurate cost Estimation
- Increased percentage of contracted roads in a state of „fair and poor" condition.
- Under accomplishment of contracted road maintenance projects
- Cost overrun in road maintenance projects

The results of these case studies showed that routine and periodic maintenances are suffering from poor cost estimation, scarcity of allocated contractual budget, cost overruns, under accomplishment of contracted assets and poor condition of roads at the end of contracted period.

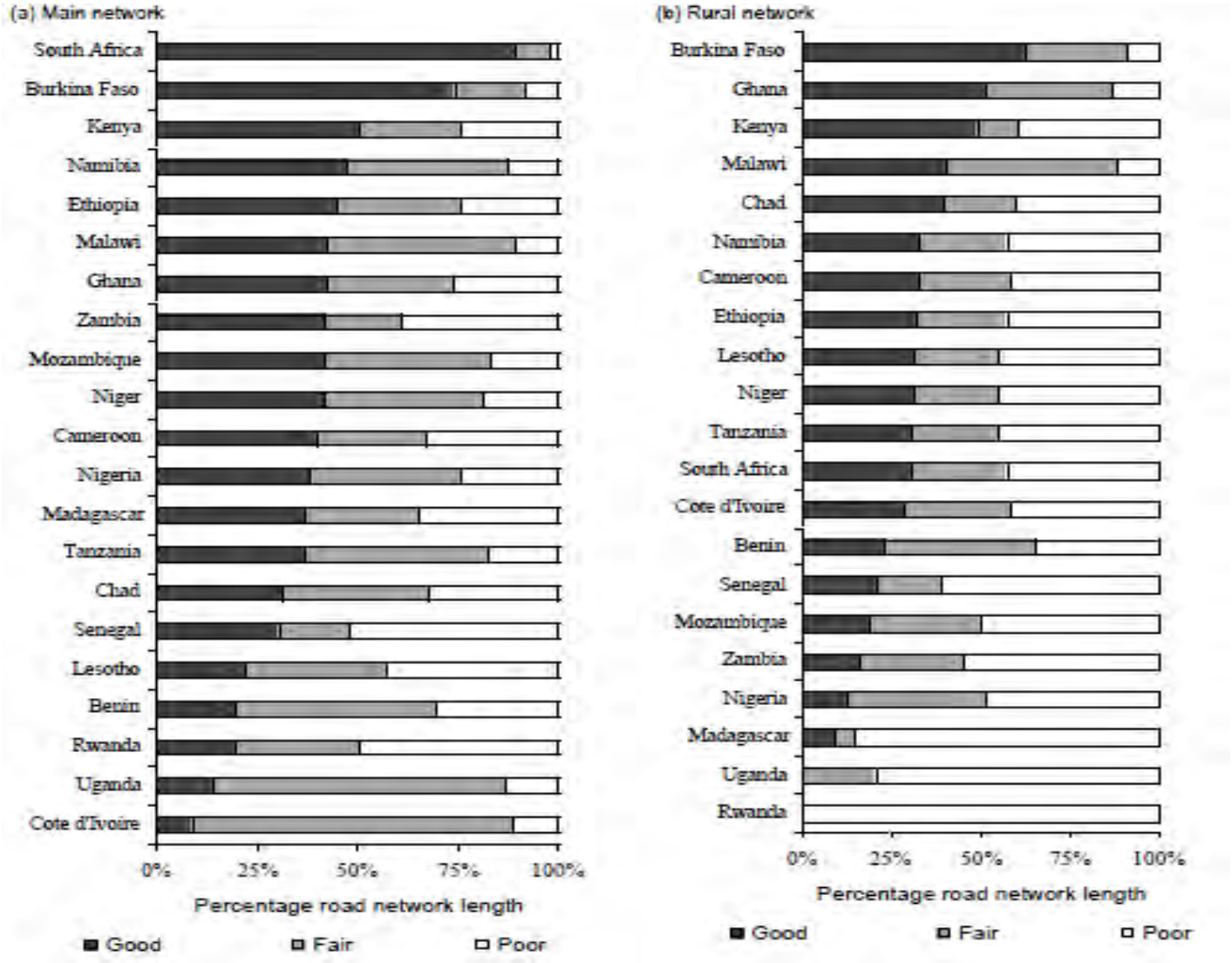
This is in line with World Bank (2008), a study conducted on sub Saharan African roads in relation to road maintenance unit costs for roads that have recently undergone a significant escalation, which threatens to further dilute the adequacy of current budget allocations. These escalations can be attributed to a lack of competition and to increases in the prices of road-construction inputs, most traceable to the recent escalation in the oil price.

The study further stressed that with road maintenance costs rising, it is more important than ever that engineering standards should be cost effective. On average around 30 percent of main road networks are over budgeted relative to observed traffic volumes, while only 10 percent of main road projects (and 15 percent of rural projects) are under budgeted. The failure to follow appropriate engineering standards suggests that resources have been wasted, but it also points to the way to cost savings in the future. Greater efforts are also needed to adapt road design standards to local conditions and materials so as to avoid excessive costs in road construction.

The other result of the case study was poor condition of contracted roads, which is line with the study of World Bank (2008) on sub Saharan countries. On average, about half of sub Saharan main network is in good condition and a further third in fair condition. The same cannot be said for the rural network. In the countryside, only about a quarter of the road network is in good condition and a further quarter in fair condition. Things may be improving, however. The limited time series evidence available suggests that most countries have achieved improvements in road

quality in recent years. Notwithstanding substantial variation in the percentage of roads in good condition, there is surprisingly little variation in the asset value of road networks as a percentage of its potential maximum were it all to be in good condition. All countries realize at least 70 percent of this potential asset value, suggesting they have concentrated their efforts on preserving the high-value paved road network.

Figure 4.1 below shows the status of road conditions in sub Saharan countries.



Source: (World Bank, 2008 citing SSATP RMI Matrix, 2007; AICD RONET Database, 2008)

Figure 4.1: Road conditions in sub Saharan Africa

4.3 Desk Study

Desk study was chosen as one of the instruments to assess and obtain actual data about the practices of road maintenance contracts from relevant studies, reports and documents. Accordingly the 2nd research Questions "Can performance Based contracting system be a solution in improving the federal roads in the country" and the 4th research questions "What are the lessons to be learned from other countries in implementing performance based contracting system in road maintenance" were searched from desk study.

All case studies taken above are contracted under traditional unit rate contract. The results of traditional Road Contracts are in many cases less-than-optimal. The problem is 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. Even if the work is carried out according to plan and considerable money is spent, the overall service quality for the Road user suffers from deficiencies in the original design, aggravated by inadequate maintenance

4.3.1 Study of performance Based Road Maintenance Contracting System

4.3.1.1 General Overview

According to NCHRP (2009), the hallmark of PBMC is to pay a contractor based on the results achieved, not on the methods for performing the work. PBMC is an approach to contracting that provides disincentives, incentives, or both to the contractor to achieve performance standards or targets for measurable outcomes and sometimes outputs. Measures of performance are often expressed in terms of levels of service (LOS) represented by specific rating scales corresponding to the condition of different assets achieved or to the outcomes of a particular type of maintenance service. Measures also may be expressed in response times.

The disincentives or incentives can consist of reductions or increases in payments for respectively falling short or exceeding the desired targets. Some disincentives or incentives are not directly tied to measurable outcomes and outputs. These disincentives or incentives include liquidated damages for failing to satisfy a contract provision, an award fee for satisfying qualitative criteria, and a contract extension if the contractor performs well.

Ethiopia Uses traditional maintenance contracts for maintenance works, in which the Contractor is responsible for the execution of works which are normally defined by the Road Administration or the Employer, and the Contractor is paid on the basis of unit prices for different work items, i.e., a contract based on "inputs" to the works.

Under this traditional way of "contracting out" maintenance works, it has been observed that even if a lot of work is carried out and much money is spent, the overall service quality for the road user depends on the quality of the design given to the Contractor who is not accountable for it and the results are sometimes not satisfactory.

According to World Bank (2002), the Performance-Based Management and Maintenance Contract try to address the issue of inadequate incentives. During the bidding process, contractors compete among each other by proposing a fixed monthly lump-sum fee per km of road to be paid to them.

It is important to understand that contractors are not paid directly for "inputs" or physical works (which they will undoubtedly have to carry out), but for "outputs," i.e., the initial rehabilitation of the road to pre-defined standards (if so required by the bidding documents), the maintenance service of ensuring certain quality levels on the roads under contract and specific improvements (if so required by the bidding documents). The monthly lump-sum remuneration paid to the Contractor will cover all physical and non-physical maintenance services provided by the Contractor, except for unforeseen emergency works which would be remunerated separately. The initial rehabilitation works which have been explicitly specified by the Employer in the contract would be quoted on the basis of measurable output quantities and paid as performed. In order to be entitled to the monthly payment for maintenance services, the Contractor must ensure that the roads under contract comply with the service quality levels which have been specified in the bidding document. It is possible that during some months he 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 the monthly payment remains the same as long as the required service levels are complied with.

One fundamental feature of the performance-based contract is that the Contractor is responsible for designing and carrying out the actions he believes are necessary in order to comply with the service quality levels stated in the contract. 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.

Under the performance-based contract, the Contractor has a strong financial incentive to be efficient. In order to maximize profits, he must reduce his activities to the smallest possible volume of intelligently designed interventions, which nevertheless ensure that pre-defined outputs (measured indicators of service level) are achieved and maintained over time. This type of contract makes it necessary for the Contactor to have a good management capacity. Here, "management" means the capability to define, optimize and carry out in a timely basis the physical interventions which are needed in the short, medium and long term, in order to guarantee that the roads remain above the agreed service quality levels.

Maintaining a road network includes routine and periodic tasks. Routine maintenance consists of many different tasks frequently necessary to maintain the function of the road (such as pothole repairs, cleaning of drainage, sealing of cracks, cutting of vegetation, etc.). Periodic maintenance consists of predictable and more costly measures of a less frequent nature designed to avoid road degradation (such as resurfacing, asphalt concrete overlays, etc.). Intelligent management, the timeliness of interventions and the adequacy of technical solutions are critical. It is expected that the use of private specialized firms under performance-based contracts will unleash significant efficiency gains, and stimulate innovation in comparison with traditional road administration practices (World Bank, 2002).

Road conditions can be expressed through indicators for service quality levels, and these are used under the performance-based contract to define and measure the desired performance of the Contractor. In the Performance-Based Management and Maintenance Contracts, the service level indicators are thus the accepted minimum thresholds for the quality levels of the roads for which the Contractor is responsible.

Under the terms of the contract, the Contractor will also be responsible for the continuous monitoring and control of road conditions and service levels for all roads or road sections included in the contract. This will not only be necessary to fulfill the contract requirements, but it is an activity which will provide him with the information needed in order to be able (i) to know the degree of his own compliance with service level requirements, and (ii) to define and plan, in a timely fashion, all physical interventions required to assure that service quality indicators never fall below the indicated thresholds.

According to Zietlow (2004), the main reasons for implementing performance based contract are to:

- Reduce maintenance costs through the application of more effective and efficient technologies and work procedures;
- Provide transparency for road users, road administrations and contractors with regard to the conditions roads have to be maintained;
- Improve control and enforcement of quality standards; and
- Improve overall road conditions

Case studies conducted on ten districts shows that road maintenance projects suffer from cost overruns, poor condition of roads and road agencies expenditure uncertainty. Zietlow (2004), argues that performance based road maintenance contracting system helps to minimize the cost of maintenance while improving the condition of contracted road assets further providing transparency for road users.

4.3.1.2 Cost Saving

According to the data obtained from ERA (2014), the cost of road maintenance has passed the allocated budget significantly in the past ten years. Table 4.51 below shows the cost of road maintenance for routine, periodic and emergency works for the past ten years.

Table 4.51: Maintenance Budget and Disbursement on the Federal Network

Year	Routine and Periodic Maintenance			Emergency and other Works		
	Budget (Millions)	Disbursement (Millions)	%age Acc	Budget (Millions)	Disbursement (Millions)	%age Acc
1997/98	158.4	117.9	74.4	10.8	5.6	51.9
1998/99	156.9	123.5	78.7	15.2	12.5	82.2
1999/00	152.0	118.2	77.8	17.0	15.2	89.4
2000/01	114.0	140.4	123.2	70.8	27.8	39.3
2001/02	119.7	176.2	147.2	178.0	31.0	17.4
2002/03	121.5	115.7	95.2	35.1	68.6	195.4
2003/04	127.0	192.8	151.8	163.2	140.5	86.1
2004/05	63.5	137.1	215.9	162.2	482.6	297.5
2005/06	144.1	172.5	119.7	112.4	298.4	265.5
2006/07	150.0	230.3	153.5	257.8	394.7	153.1
2007/08	186.7	234.8	125.7	161.3	400.6	248.3
2008/09	227.8	527.8	231.7	200.7	500.7	249.4
2009/10	223.4	516.9	251.5	196.2	491.1	250.3
2010/11	158.9	368.1	231.6	140.0	367.4	262.4
2011/12	426.9	493.1	115.5	320.3	310.9	97.1
2012/13	302.1	440.7	145.8	439.9	410.2	93.2
2013/14	516.8	577.2	111.6	370.9	376.1	101.4

Source: (ERA, 2014)

Based on the current practices of ERA, routine maintenance is estimated at Birr 200,000 on average per km for gravel roads and Birr 400,000 for asphalt roads. During the analysis a price escalation of 7% has been considered. The cost estimated has dropped based on the assumption that the road under consideration will be constructed or improved. It could safely be estimated that the new roads would not include activities involving heavy capital maintenance, which in turn leads to a reduction of cost. The Schedule of Routine Maintenance for Federal and Regional Roads and City roads are presented in the following tables.

Table 4.52: Schedule of Routine Maintenance needs for federal and regional roads

Year	Asphalt		Gravel		Total	
	Length	Cost (Millions)	Length	Cost (Millions)	Length	Cost (Millions)
2015/16	8,730	3,776.89	11,378	2,164.06	20,107	5,940.94
2016/17	9,416	4,277.37	11,897	2,375.91	21,312	6,653.29
2017/18	9,546	4,553.25	12,357	2,591.17	21,902	7,144.42
2018/19	9,622	4,818.98	12,525	2,757.72	22,146	7,576.70
2019/20	9,817	5,162.48	12,481	2,885.43	22,297	8,047.91
Total	**47,131**	**22,588.97**	**60,638**	**12,774.29**	**107,764**	**35,363.26**

Source: (ERA, 2014)

Table 4.53: Schedule of Periodic Maintenance Needs for federal and Regional roads

Year	Asphalt		Gravel		Total	
	Length	Cost (Millions)	Length	Cost (Millions)	Length	Cost (Millions)
2015/16	599	1,592.20	1,120	662.02	1,719	2,254.23
2016/17	730	2,037.44	959	595.20	1,689	2,632.64
2017/18	151	442.51	1,051	684.92	1,202	1,127.43
2018/19	245	753.89	854	584.36	1,099	1,338.25
2019/20	126	407.10	925	664.59	1,051	1,071.69
Total	**1,851**	**5,233.14**	**4,909**	**3,191.10**	**6,760**	**8,424.24**

Source: (ERA, 2014)

According to the data obtained from ERA, the following procedure were adopted in determining the length of road network that require routine maintenance,

- For gravel and rural roads, those roads under rehabilitation, upgrading and periodic maintenance are deducted to arrive at the length of roads expected to be included in routine maintenance and
- In the case of asphalt roads, the roads contracted out or scheduled for periodic maintenance and rehabilitation are deducted to arrive at that paved road network to be put under routine maintenance.

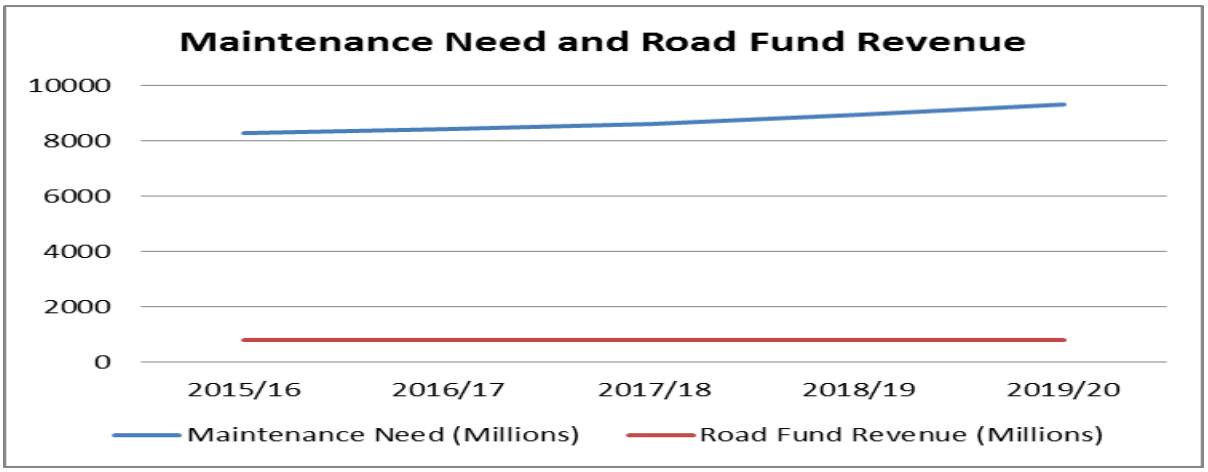
On the basis of the foregoing, the total financial requirement for both routine and periodic maintenance for is estimated at about Birr 43,787.5 million (USD 2,134.7 million using current prevailing rate of 1USD=20.512098). The cost of road maintenance in the coming years is expected to be covered from Road Fund. A rough analysis is made to estimate the road fund revenue for three years in future assuming the current fuel levy rate, municipal and sales taxes; and the expected resumption of collection vehicle license renewal fee based on axle weight and configuration; and overloading fine (ERA, 2014).

The annual disbursement schedules or need for maintenance and expected Road Fund revenue collection are shown below: The expected road fund revenue is far from the maintenance need (shown hereunder). The forecasted revenue does not include the accumulated deposit since the establishment of the fund.

Table 4.54: Comparison of Maintenance Needs and road Fund Revenue

Year	Maintenance Need (Millions)	Road Fund Revenue (Millions)	Gap (Millions)
2015/16	8,282.3	808.32	7,473.98
2016/17	8,415.2	808.32	7,606.88
2017/18	8,617.3	808.32	7,808.98
2018/19	8,955.4	808.32	8,147.08
2019/20	9,320.1	808.32	8,511.78
Total	**43,590.3**	**4041.6**	**39,548.7**

Source: (ERA, 2014)



Graph 4.2: Comparison of Maintenance Needs and road Fund Revenue

It can be realized from table 4.54 that the forecasted revenue from the Road Fund doesn‟t match with the maintenance need. The Figure is comparing the total maintenance need expected to be covered from the Road Fund versus the road fund revenue to show how unsustainable and unstable the flow of fund over time is.

Moreover, Case studies on the ten road maintenance projects contracted under routine and selected periodic road maintenance projects in 2013/2014 on Ethiopian federal road revealed that the cost of maintaining the federal roads has increased substantially. On the basis of rough estimation done on the need for maintenance money for the coming five years a data obtained from ERA, it is clear that the maintenance need overpasses the available fund. The results indicated that there is a gap between maintenance costs and allocated budget which requires a cost effective way of maintaining the road network.

However, the previous studies conducted on developed countries showed that implementing PBMCs minimizes the cost of road maintenance projects.

The NCHRP (2009), citing (Pakkala 2002; Segal *et al.,* 2003; Stankevich *et al.*, 2005; Zietlow 2005a) states that PBMC saves the cost of road maintenance projects. Though the literature does not cite the base for comparison, there is a considerable cost reduction in countries implementing performance based road maintenance contracts. Table below shows cost reduction of different countries using performance based contracting system.

Table 4.55: Cost savings of different countries under PBMC over the conventional contracts

Country	**Cost saving (%)**
Norway	About 20-40%
Sweden	About 30%
Finland	About 30-35%; about 50% less cost/km
Holland	About 30-40%
Estonia	20-40%
England	10% minimum
Australia	10-40%
New Zealand	About 20-30%
USA	10-15%
Canada (Ontario, Alberta, & British Columbia)	About 10%; About 20% ; and Some, but might be in the order of 10%

Source: (Pakkala, 2005)

But, Ribreau (2004), argues that many maintenance agencies regard the cost savings of performance-based contracting as unproven or difficult to substantiate. It is difficult to establish the difference in the cost of government agency forces and private contractors performing the same types of maintenance work.

Ribreau also further stressed the problem by raising the difficulty of establishing defensible direct and indirect costs for each type of maintenance activity in both the public and private sectors. The private firms will not publicize their cost structure, because it would undermine their ability to compete successfully.

In 2007, a Swedish analyst published articles that attempted to apply regression analysis to determine whether cost savings resulted from PBMC in Sweden, southern Canadian provinces, and the state of Washington (Stenbeck, 2007). Although the analysis suggested that cost savings were achieved contrary to the author"s expectations, the estimated savings was not defensible for many reasons, including unclear explanations, choice of explanatory variables, and a small data set.

In Canada Ontario, the Road Transport Agency determined that, during the first year, the private entity was able to achieve, relative to the state forces, a 16% savings in costs, a 22% improvement in productivity, and a 13% improvement in the condition of assets (Segal *et al.,* 2003). On the other hand the World Bank reported a 13% improvement in condition accompanied by a cost reduction in the 20% to 30% range, but it is not known over how many years of the contract these results apply. The bid price was 25% lower than estimated.

4.3.1.3 Expenditure Certainty

According to data obtained from ERA, most of the cost overrun resulted from the current activity unit price developed some years ago, possibly in early 2000 E.C. that has not been revised since. The unrevised unit rate has forced the Road Fund Agency to face expenditure uncertainty and is finding it difficult to allocate sufficient budget for maintenance projects. In 2005 E.C., ERA had commissioned a study aiming to structure unit rate analysis for maintenance works to be used for negotiations with Road fund, but the unit rates have not been revised. A case study conducted on ten road maintenance projects undertaking routine and periodic project on Ethiopian Federal

Roads showed that the cost overrun is more than 102,647,058.80 Birr in 2013/2014 which is incurred directly to the road fund administration.

But, the road maintenance contracting agency using PBMCs enjoys full control of expenditures without unexpected variation orders. This is because PBMCs is paid to the contractor on a fixed lump sum Contracts (World Bank, 2005).

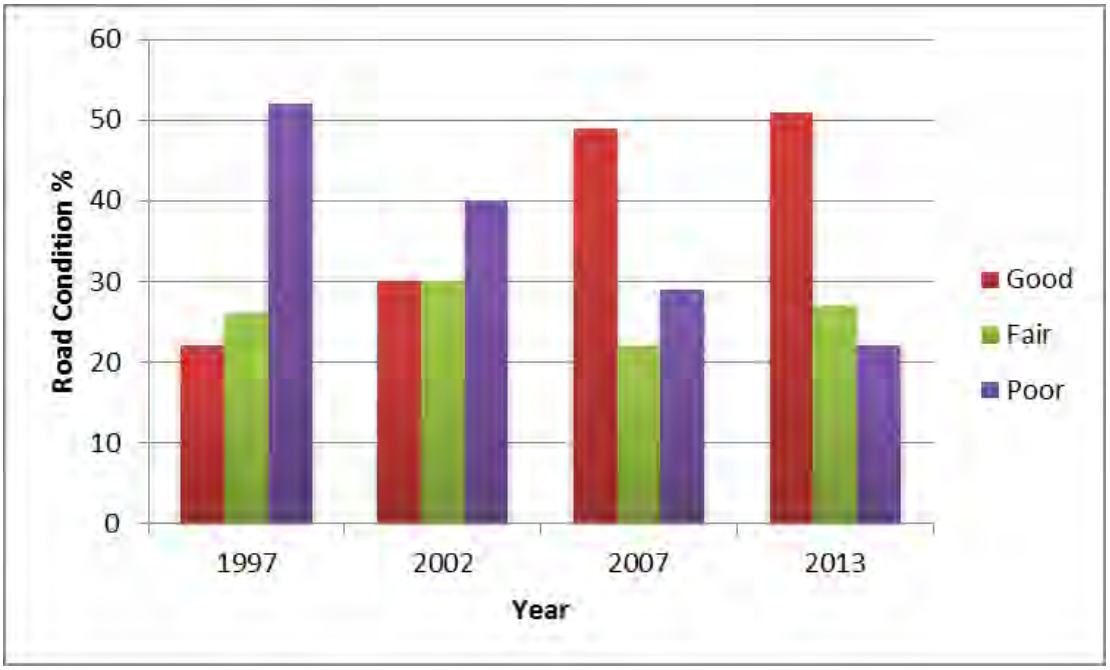
4.3.1.4 Improved Condition of Roads

Improving the condition of Ethiopian federal roads is still a challenge. The improvement of the road network in the country is only changing the condition of the network slowly. In the first year of RSDP, 52% of the road network was found to be in poor condition and only 22% was in reasonably in good condition. Owing to on-going rehabilitation, upgrading and maintenance intervention under the program, the proportion of the road network in good condition has increased to 50 percent and the road in poor condition has declined to 22%. The proportion of roads in good condition has overtaken the proportion of roads in poor condition from 2004 onwards and particularly the last two years owing to a massive intervention in terms of rehabilitation, upgrading and maintenance on major roads. Another observation is that the roads in fair and poor condition are declining shifting to good condition since the year 2002 (ERA, 2014). According to data obtained from Ethiopian Roads Authority nearly half of the road falls under „fair and poor" state. Table below shows the status of Road conditions.

Table 4.56: Road Status Condition

Year	Good	Fair	Poor
1997	22	26	52
2002	30	30	40
2007	49	22	29
2013	51	27	22

Source: (ERA, 2014)



Graph 4.3: Road Condition Data

The consequence of this situation was grave, and vehicle-operating costs were increasing from time to time. The extra road user costs resulted in increased transportation costs that would be transferred, through operators and shippers, to the final consumers of the service.

Nevertheless, many road agencies have acknowledged that on completion of PBMCs, road assets are generally returned either in an improved condition or in a condition similar to when the PBMC was awarded, but not in a worse condition (World Bank, 2005). The Department of Transportation in Texas State, USA, has also reported "after the first year of the performance-based contracts, road facilities were rated at an average of 91%, an 18 percent increase over their pre-contract condition" (FHWA, 2005). Similarly, Argentina has reduced the share of roads in poor condition from 25 percent to less than 5 percent by the end of 1999 due to the PBMC approach (Liautaud, 2004).

Stankevich *et al.* (2006), stressed that using PBMCs, Argentina had shown a significant effect on asset condition. The percent of roads in fair to good condition increased from 59% to 95%. The percent in critical to poor condition declined from 41% to 5%. Segal *et al.* (2003), referring to the Reason Public Policy Institute reported that since New South Wales started this performance contract, roadway condition has improved approximately 15% though the World Bank reported a

13% improvement in road conditions.

4.4 Interview

The 3rd research question was "What are the drawbacks in implementing performance based contracting system for the maintenance of federal roads in Ethiopia?" The answer for this question and supplementary information for other research questions were searched from key informants through interview in order to deepen the findings of the research.

Table 4.57: Socio-demography of the Interviewed Informants

Socio-demography		**Number of Informants**			
		Civil Eng.	**Highway Eng.**	**Construction Mgt**	**Total**
Educational status	BSc	2	-	2	4
	MSc	7	-	-	7
Total		**9**		**2**	**11**
Experience in the road sector	0-6 years	-	-	-	-
	6- 10 years	1	-	1	2
	≥10 years	8		1	9
Total		**9**	**-**	**2**	**11**

4.4.1 Draw Backs in Implementing Performance based Road Maintenance Contracts

The following are some of the draw backs obtained from interview and desk study in implementing PBMCs.

4.4.1.1 Cultural Change

Information obtained from an interview of key informants involved in Ethiopian Federal Road Maintenance, supported with a desk study from literatures shows that a significant shift in culture is required while implementing performance based road maintenance contracts.

According to the informants, ERA uses traditional road maintenance contracting system i.e. the Contractor is responsible for the execution of works, which are normally defined by the Road Administration or the Employer and the Contractor is paid on the basis of unit prices for different work items, i.e. a Contract based on "inputs" to the works. The results of traditional Road Contracts are in many cases less-than-optimal. The problem is 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. Even if the work is carried out according to plan and considerable money is spent, the overall service quality for the road user suffers from deficiencies in the original design, aggravated by inadequate maintenance.

Regarding to World Bank (2002), PBMCS tries to address the issue of inadequate incentives. In PBMCs the contractor is responsible for performance and is free to choose the methods it wishes to achieve performance. A true performance based contract promotes innovation and efficiency, which are major benefits of this approach. Shifting form works based on "input" to delivering performance "out puts" requires cultural change by the governmental agency and the contractor.

4.4.1.2 Insufficient Contractors Capacity

According to the informants, the road maintenance contractor in the country taking most of routine and periodic projects is ERCC, a new government development agency; which was under Ethiopian Roads Authority and established under Council of Ministers Regulation No 248/2011.on July 08/2011.

Before ERCC was established, it was working as operation using of ERA (which changes its name and internal organization structure) for 60 years. Most of the other GC1 and RC1 contractors in the country are engaged with the construction of new roads giving less attention to road maintenance.

The selection criteria for contractors involved in PBMCs is of "best value" not "always lowest bidder", since the road agency wont risk losing its asset to unqualified contractors, not many fulfill this requirements requested by PBMCs. Furthermore, maintenance quality assurance has been adopted by a large number of states and is frequently used in PBMC (Smith *et al.*, 1997; Stivers *et al.*, 1999). According to informants, even ERCC is on the way to adopt QMA consulted by Australian company SMEC, which many contractors in Ethiopia do not possess yet. The other draw back mentioned by the informants is lack of a contractor who has prior experience in implementing Performance based road maintenance contracts.

However, NCHRP (2009), stated that adequate contractor capacity is necessary to ensure meaningful competition and to be confident that a contractor and its subcontractors can achieve the performance standards.

4.4.1.3 Fear of Risks

Interview findings has revealed that most contractors are scared off taking too much risks that may jeopardize their long term stability.

According to NCHRP (2009), PBMC is a two-way street, a partnership. If an agency goes too far in trying to shift risks to contractors, there can be a negative effect. For example, if an agency forces a contractor to bear all the risks of severe weather in a hurricane prone state, the contractor may raise its price to perform the work, refuse to work in an area, or go out of business. Some of the risks involved in performing performance based maintenance are:

- Poor quality of construction
- Unexpectedly severe weather
- Unanticipated environmental problems
- Emergencies
- Unanticipated legislative change
- Unexpected traffic growth
- A short-term focus that fails to minimize long-term life-cycle costs
- Difficulty in acquiring the resources needed to perform the work (e.g., subcontractors)
- The possibility of having to correct problems covered under a warranty.

4.4.1.4 Incomplete and Insufficient Inventory and condition data

According to the informants, the current road maintenance practice in the country is suffering from insufficient inventory and condition data. During a visit to road maintenance offices, the researcher was able to witness that there are insufficient survey data and was able to find road condition data only for the year 2013/2014. This however, is in line with the findings of NCHRP (2009), in which one of the impediments to implementing PBMCs is lack of incomplete and insufficient data from road agency.

4.4.1.5 Inability to Achieve Sufficient Competition

As discussed earlier very few contractors in the country have the capacity to fulfill the requirements requested by road agencies when implementing PBMCs. According to the informants, lack of contractor‟s capacity possesses its own problem by inhibiting competition between contractors and leaving the road agency with no alternatives. The agency loses the benefits obtained from fair competitions.

4.5 Lessons to be Learned from Countries using PBMCS for Road Maintenance

According to NCHRP (2009), the following lessons can be taken from countries who have successfully implemented PBMCs. These are:

1. PBMC involves politically and socially sensitive decisions.

2. A significant cultural shift of both the owner–agency and the contractor is usually required for PBMC to be successful.
3. Adequate contractor capacity is necessary to ensure meaningful competition and to be confident that a contractor and its subcontractors can achieve the performance standards.
4. The more an agency does PBMC, the more its role shifts from managing and performing maintenance work to planning, contract administration, and contractor oversight. The skills an agency requires must shift accordingly.
5. Agencies beginning with PBMC could start with projects that have a limited scope, such as one maintenance activity) or relatively few activities (e.g., routine maintenance) on a section of road.
6. Performance measures must be clearly defined, the measurement process repeatable, and targets realistic and in line with the agency goals. In short, performance specifications must be clearly defined.
7. The contract must have a proper incentives and disincentives
8. A firm funding commitment is required for multiyear performance-based contracts
9. Cost savings are highly desirable but difficult to document. Cost savings are often claimed based on the difference between the agency‟s estimated cost and the amount of the contract award.
10. Quality (LOS) sometimes suffers during the first year on long-term total asset management contracts. Quality is likely to improve from the first year of performance-based contracts.
11. If the highway or network is severely deteriorated, it needs to be reconstructed or rehabilitated before standard performance-based maintenance procedures begin. In numerous cases around the world, the contractor has been responsible first for a rehabilitation phase and then a maintenance phase.
12. Partnering and trust are imperative between the maintenance organization and the contractor.
13. A poorly written contract, or either party misreading significant portions of the contract to serve its own interests or point of view, may lead to failure.
14. Failure is likely to occur if agency staff believes strongly that contractors are taking their jobs. If agency staff is responsible for monitoring contractor performance, they may be

overzealous in holding contractors to timeliness requirements and other performance standards.

15. Expect failure to occur occasionally because success cannot occur 100% of the time. At times, certain events and conditions will prevent performance-based contracting or performance-based warranty contracting from working. An agency with poor contractor performance or a disappointing outcome might try to learn from its experience and carefully try again.
16. Innovation will be the most significant under long term, performance-based, lump-sum agreements with selection based predominantly on best qualifications.
17. The client will experience a perceived loss of control and flexibility.
18. Three ways to monitor contractor performance have been observed and each has different implications. First, the contractor can monitor itself. This approach requires a strong bond of trust with the contracting agency and is generally the least expensive. Second, the contracting agency can monitor the contractor‟s performance. Agencies using this approach believe they can observe contractor performance effectively and have a good deal of control. Third, an independent third party can monitor the contractor. This method provides the most objectivity but is the most expensive.
19. A program plan that lists upcoming performance-based procurements is valuable for alerting qualified contractors to bidding opportunities. This could be part of a long-term procurement strategy that sends a message to industry.
20. Develop criteria for prequalification of contractors and use the criteria to identify a suitable number of competitors.
21. Share risks in an equitable manner; shift risks appropriately-the contractor should not bear all the risks.

According to Zietlow (2004), the following are some of the lessons taken from countries implementing performance based road maintenance contracts.

1. Securing finance on a regular basis is critical to success. Normally, Performance Contracts have duration between 4 and 10 years. It is important to secure financing for the entire contract period before starting such a contract.
2. Each Performance Contract has to be tailored to each specific situation. Performance

Contracts are still in an early stage of development and differ widely from country to country and even within countries. Studying the experiences of existing Performance Contracts in several countries is recommended before embarking on this new type of contract

3. Well-qualified contractors and inspectors are keys to the success of Performance Contracts. Training programs which have been conducted for small-scale enterprises and inspectors in Uruguay and Honduras have shown good results. Equally, traditional contractor require training in modern management techniques and the application of new maintenance procedures and technologies.
4. Proper performance monitoring and strict application of penalties for noncompliance have proven to be critical to the success as well. Wherever road administrations did not properly monitor the performance of the contractor or did not apply proper penalties for non-compliance, contractor's performance was deficient.
5. Performance indicators need to be developed further. The development of performance indicators is still at its early stage. Until now each road administration has developed its own indicators by slightly modifying the ones they used before for in-house labor or contractors.
6. Performance Contracts might not result in cost savings immediately. Contracts also might turn out to be more expensive than expected. Recently, the DNER of Brazil had to cancel a tender for Performance Contracts, as the prices offered were much higher than expected. This was mainly due to the high risks perceived by the bidders that the government might not honor its payment commitments.

4.6 Road Maintenance Unit rate

Regarding to Smec (2014), the current activity unit price for routine and periodic maintenance in Ethiopia was developed in early 2000 E.C, and has been not been revised since then. The cost of materials, labor rates, and machinery rental rates has increased many times in the intervening period. Tables 4.58, 4.59 and 4.60 below shows comparison of road maintenance unit price for periodic and routine developed in early 2000 E.C and the current price.

Table 4.58: Comparison of Unit rates for Periodic Maintenance between 2000 E.C and 2007 E.C (ERCC, 2014)

Code	Name of Activity	Unit	Unit Rate (Birr/unit)			
			2000 E.C (A)	2007 E.C (B)	DIFFERENCE (B-A)	PERCENTAGE INCREASE (B/A*100)
121	Culvert Cleaning	m^3	69.27	155.71	86.43	225
122	Ditch Cleaning (Manual)	m	6.90	30.80	23.90	446
125	Mortared Masonry Repair	m^3	517.36	1,156.34	638.98	224
126	Dry Masonary Repair	m^3	259.51	442.90	183.38	171
127	Gabion Structure	m^3	461.08	832.73	371.66	181
131	Brush Clearing	m^2	0.28	0.74	0.45	260
210	Asphalt Patching (Seal Coat)	m^2	25.19	59.53	34.34	236
211	Asphalt Patching (Single Surface Treatment)	m^2	28.94	61.96	33.01	214
212	Asphalt Patching (Double Surface Treatment)	m^2	50.24	113.13	62.89	225
213	Asphalt Patching (Cold Mix)	m^3	2,215.73	6,799.76	4,584.04	307
214	Asphalt Patching (Hot mini-mix))	m^3	2,511.75	6,750.00	4,238.25	269
215	Crack Sealing (Individual cracks)	Lm	22.90	46.71	23.81	204
230	Ditch Cleaning (Machine)	km	3,686.75	7,164.73	3,477.99	194
240	Shoulder Blading	Km	653.74	1,289.65	635.91	197
241	Shoulder Rehabilitation	m^3	99.81	162.06	62.25	162
251	Concrete Construction (Class 1)	m^3	1,809.93	4,821.99	3,012.06	266
252	Concrete Construction (Class 2)	m^3	1,453.56	3,300.47	1,846.92	227
253	Steel Reinforcement	kg	16.53	49.04	32.51	297
310	Single Bituminous Surface Treatment (SBST)	m^2	16.49	55.63	39.15	337
311	Double Bituminous Surface Treatment (DBST)	m^2	35.76	108.09	72.33	302
312	Mix-In-Place Overlay (Cold-mix)	m^3	1,462.85	6,704.57	5,241.72	458
313	Asphaltic Concrete Overlay	m^3	2,109.27	6,325.00	4,215.73	300
314	Bitumen Prime Coat	Lt	15.72	45.26	29.54	288
315	Bitumen Tack Coat	Lt	17.22	45.52	28.30	264
317	Gravel resurfacing (Select Material)	m^3	130.37	181.47	51.10	139
318	Gravel resurfacing (Crushed aggregate)	m^3	282.68	524.12	241.44	185
510	Overhaul	m^3km	3.82	6.16	2.35	161
M10	Cold Mix Production (Pug-mill)	m^3	1,234.03	6,298.88	5,064.85	510
M11	Cold Mix Production (Mix-In-Place)	m^3	1,030.55	4,703.71	3,673.16	456
M12	Hot Mini-Mix Production (Mobile Unit)	m^3	1,449.87	3,836.28	2,386.41	265
M13	Hot Mini-Mix Production (Central Plant Mix)	m^3	1,533.37	3,958.94	2,425.56	258
M14	Crushed Aggregate (Bituminous Surfacing)	m^3	319.12	333.98	14.86	105
M15	Crushed Aggregate (Road Base)	m^3	210.91	370.41	159.49	176
M16	Selected Material (Gravel Road Surfacing)	m^3	29.08	42.63	13.55	147
M17	Crushed Aggregate (Gravel Road Surfacing)	m^3	188.27	354.26	165.99	188
M18	Masonary Stone Production	m^3	58.83	98.81	39.99	168
434A	Base Course Placing	m^3	323.31	490.70	167.39	152
412B	Common Excavation to Embankment	m^3	42.33	121.44	79.12	287
415B	Common Excavation to Waste	m^3	59.27	63.42	4.16	107
417	Borrow Placing	m^3	252.71	182.66	-70.06	72
414	Rock Excavation	m^3	44.30	287.27	242.97	648
464	Class "B" Masonary	m^3	491.95	1,461.63	969.68	297
452	Pipe Production(36")	Lm	703.91	2,592.40	1,888.49	368
453	Pipe Installation(36")	Lm	1,148.35	4,006.33	2,857.98	349
418	Road Bed Preparation (Gravel Road)	Lm	60.06	85.52	25.46	142
419A	Road Bed Preparation (Asphalt Road)	Lm	81.30	145.96	64.67	180
421B	Borrow Production	m^3	10.94	46.40	35.47	424
472	Detour Construction	Lm	22.95	103.18	80.23	450
461	Structural Excavation in Common Material	m^3	56.35	126.39	70.04	224
417	Granular Backfill	m^3	84.48	150.95	66.46	179
411	Clearing & Grubbing	Ha	6,653.94	23,109.37	16,455.43	347
471	Paved Waterway	m^2	139.51	325.34	185.84	233
	Demolishing Existing Masonry	m^3	113.53	233.18	119.66	205

Table 4.59: Comparison of Unit rates for Routine Maintenance between 2000 E.C and 2007 E.C (ERCC,2014)

Code	Name of Activity	Unit	Unit Rate (Birr/unit)			
			2000 E.C (A)	2007E.C (B)	DIFFERENCE (B-A)	PERCENTAGE INCREASE (B/A/100)
110	Spot Repair Gravel Road-Selected Material	m^3	137.05	199.63	62.58	145.67
111	Spot Repair Gravel Road-Crushed Aggregate	m^3	286.00	488.50	202.49	170.80
121	Culvert Cleaning	m^3	66.82	155.71	88.89	233.02
122	Ditch Cleaning (Manual)	m	5.50	30.80	25.31	560.48
123	Repair Erosion Damage (Selected fill)	m^3	117.63	206.06	88.43	175.18
124	Repair Erosion Damage (Rock fill)	m^3	210.63	313.60	102.97	148.89
125	Mortared Masonry Repair	m^3	459.53	1,156.34	696.81	251.64
126	Dry Masonary Repair	m^3	252.21	442.90	190.68	175.60
127	Gabion Structure	m^3	426.80	832.73	405.93	195.11
131	Brush Clearing	m^2	0.26	0.74	0.48	281.73
210	Asphalt Patching (Seal Coat)	m^2	25.15	59.53	34.37	236.66
211	Asphalt Patching (Single Surface Treatment)	m^2	28.81	61.96	33.14	215.03
212	Asphalt Patching (Double Surface Treatment)	m^2	49.74	113.13	63.40	227.46
215	Crack Sealing (Individual cracks)	Lm	22.85	46.71	23.86	204.39
216	Pothole Reinstatement (Double Surface Treatment)	m^2	48.09	112.64	64.55	234.21
219	Pothole (Base Failure Repair)	m^3	307.11	468.64	161.53	152.60
220	Blading Gravel Road (Light)	Km	656.30	1,725.22	1,068.92	262.87
221	Blading Gravel Road (Heavy)	km	3,922.17	4,184.15	261.98	106.68
222	Gravel Provision- Selected Material (Extra- Over)	m^3	83.28	106.98	23.70	128.46
223	Gravel Provision- Crushed Aggregate (Extra- Over)	m^3	246.05	425.45	179.40	172.91
230	Ditch Cleaning (Machine)	km	2,814.99	7,164.73	4,349.75	254.52
240	Shoulder Blading	Km	463.38	1,289.65	826.27	278.31
241	Shoulder Rehabilitation	m^3	94.29	162.06	67.78	171.88
251	Concrete Construction (Class 1)	m^3	1,804.47	4,821.99	3,017.52	267.22
252	Concrete Construction (Class 2)	m^3	1,449.75	3,300.47	1,850.72	227.66
253	Steel Reinforcement	kg	16.29	49.04	32.75	301.06
309	Sand Seal Coat	m^2	13.80	58.92	45.12	426.86
310	Single Bituminous Surface Treatment (SBST)	m^2	16.01	55.63	39.62	347.41
311	Double Bituminous Surface Treatment (DBST)	m^2	35.29	108.09	72.80	306.31
312	Mix-In-Place Overlay (Cold-mix)	m^3	1,414.29	6,704.57	5,290.29	474.06
313	Asphaltic Concrete Overlay	m^3	2,064.46	6,325.00	4,260.54	306.37
314	Bitumen Prime Coat	Lt	15.80	45.26	29.46	286.50
315	Bitumen Tack Coat	Lt	16.72	45.52	28.80	272.20
316	Pavement Reconstruction (Aggregate Road Base)	m^3	319.53	464.24	144.72	145.29
317	Gravel Resurfacing (Selected Material)	m^3	130.37	181.47	51.10	139.20
318	Gravel Resurfacing (Crushed Aggregate)	m^3	282.68	524.12	241.44	185.41
410	Emergency Repair	DWs	Variable	Variable	DWs	DWs
411	Other Routine Maintenance	DWs	Variable	Variable	DWs	DWs
412	Betterment	DWs	Variable	Variable	DWs	DWs
413	Environmental Protection	DWs	Variable	Variable	DWs	DWs
510	Overhaul	m^3km	3.87	6.16	2.29	159.25
M10	Cold Mix Production (Pug-mill)	m^3	1,265.95	6,298.88	5,032.93	497.56
M11	Cold Mix Production (Mix-In-Place)	m^3	1,009.87	4,703.71	3,693.85	465.78
M12	Hot Mini-Mix Production (Mobile Unit)	m^3	1,468.97	3,836.28	2,367.31	261.15
M13	Hot Mini-Mix Production (Central Plant Mix)	m^3	1,503.30	3,958.94	2,455.64	263.35
M14	Crushed Aggregate (Bituminous Surfacing)	m^3	300.74	333.98	33.24	111.05
M15	Crushed Aggregate (Road Base)	m^3	207.20	370.41	163.21	178.77
M16	Selected Material (Gravel Road Surfacing)	m^3	38.95	42.63	3.68	109.46
M17	Crushed Aggregate (Gravel Road Surfacing)	m^3	188.27	354.26	165.99	188.16
M18	Masonary Stone Production	m^3	54.39	98.81	44.43	181.69

Table 4.60: Comparison of Unit rates for Asphalt Maintenance between 2000 E.C and 2007E.C (ERCC,2014)

Code	Name of Activity	Unit	Unit Rate (Birr/unit)			
			2000E.C (A)	2007E.C (B)	DIFFERENCE (B-A)	PERCENTAGE INCREASE (B/A*100)
210	Asphalt Patching (Seal Coat)	m^2	25.15	59.53	34.37	236.66
211	Asphalt Patching (Single Surface Treatment)	m^2	28.81	61.96	33.14	215.03
212	Asphalt Patching (Double Surface Treatment)	m^2	49.74	113.13	63.40	227.46
213	Asphalt Patching (Cold Mix)	m^3	2,137.12	6,799.76	4,662.64	318.17
214	Asphalt Patching (Hot mini-mix))	m^3	2,433.69	6,750.00	4,316.31	277.36
215	Crack Sealing (Individual cracks)	Lm	22.85	46.71	23.86	204.39
216	Pothole Reinstatement (Double Surface Treatment)	m^2	48.09	112.32	64.22	233.54
217	Pothole Reinstatement (Cold mix)	m^3	2,264.72	6,978.00	4,713.28	308.12
218	Pothole Reinstatement (Hot mini- mix)	m^3	2,541.69	6,778.00	4,236.31	266.67
310	Single Bituminous Surface Treatment (SBST)	m^2	16.01	55.63	39.62	347.41
311	Double Bituminous Surface Treatment (DBST)	m^2	35.29	108.09	72.80	306.31
312	Mix-In-Place Overlay (Cold-mix)	m^3	1,414.29	6,704.57	5,290.29	474.06
313	Asphaltic Concrete Overlay	m^3	2,064.46	6,325.00	4,260.54	306.37
314	Bitumen Prime Coat	Lt	15.80	45.26	29.46	286.50
315	Bitumen Tack Coat	Lt	16.72	45.52	28.80	272.20
M10	Cold Mix Production (Pug-mill)	m^3	1,265.95	6,298.88	5,032.93	497.56
M11	Cold Mix Production (Mix-In-Place)	m^3	1,009.87	4,703.71	3,693.85	465.78
M12	Hot Mini-Mix Production (Mobile Unit)	m^3	1,468.97	3,836.28	2,367.31	261.15
M13	Hot Mini-Mix Production (Central Plant Mix)	m^3	1,503.30	3,958.94	2,455.64	263.35
M14	Crushed Aggregate (Bituminous Surfacing)	m^3	300.74	378.21	77.47	125.76

4.7 Summary

The results of case studies conducted on the ten road maintenance districts indicated that out of the 49 routine and periodic road projects investigated, 30 projects (62.5%) suffered cost overrun while 15 projects (30.6%) suffered cost under run in their execution. For these maintenance projects, the average cost overrun was found to be 18% of the contract amount, the actual cost overrun ranging from -100% to 140 %.

The failure to properly estimate road maintenance costs has caused the agency cost overrun of 87,423,088 (ETB) than first planned. On the contrary, the analysis also indicates that Alemgena and Jimma Road maintenance projects has been over budgeted while still more than 50% and 40% of their network is under poor condition respectively.

This is in line with a study made in sub Saharan country by World Bank (2008), where it showed that nearly 30% of main road networks are over budgeted while 10% of main road projects are under budgeted. The study further stressed that the failure to follow appropriate road maintenance engineering standards has resulted in resource wastage. Table 4.62 below shows total road maintenance costs and cost overruns of the ten districts.

Table 4.61: Road maintenance costs and cost overruns of ten districts

No	Maintenance District	Total Budget For Routine and Periodic Maintenance 2013/2014 FY.(Birr)	Toatal Budget Consumed 2013/2014 FY.(Birr)	Cost Overrun/Cost Under Run (Birr)
1	Adigrat	32,700,000	52,919,000	20,219,000
2	Alemgena	101,600,000	68,922,060	(32,677,940)
3	Combolcha	50,336,254	67,150,541	16,814,287
4	Dire Dawa	57,600,000	80,157,074	22,557,074
5	Debre Markos	67,200,000	79,714,521	12,514,521
6	Gonder	61,500,000	67,445,153	5,945,153
7	Jimma	86,000,000	58,045,911	(27,954,089)
8	Nekempte	43,800,000	77,151,845	33,351,845
9	Shashemene	56,247,826	73,380,775	17,132,949
10	Sodo	45,700,000	65,220,287	19,520,287
TOTAL		**602,684,080**	**690,107,167**	**87,423,088**

The other findings of the case studies shows that more than half of the road network contracted under routine and periodic maintenance projects is categorized under „poor" condition. This, in addition with poor cost estimation and cost overruns, might force the Ethiopian maintenance industry to consider PBMC as an option in contracting tool kit.

Zietlow (2005), stated that proper implementation of PBMC saves road maintenance costs by improving the condition of contracted road assets and enables the agency to enjoy full control of expenditures without any variation.

But, proper implementation of PBMC requires a significant cultural change from input to outcome based method, fair allocation of risks between contracting agency and contractor, complete and sufficient condition data of the road networks and contractors who are capable of performing tasks with the expected quality and time.

5. CONCLUSIONS AND RECOMMENDATIONS

The main objectives of the research as mentioned earlier was to study PBMC and the existing practices of road maintenance contractual data, costs and status of contracted road conditions and make recommendations based on the findings. The following conclusions and recommendations were therefore presented.

5.1 Conclusions

Despite Governments increased maintenance intervention in recent years, most of the road network in the country is still in need of timely maintenance. The results of the case studies indicated that the current road maintenance contracting system in Ethiopia is suffering from cost overruns, inappropriate maintenance cost estimation, and poor condition of contracted road assets. In line with this, the maintenance industry is also facing expenditure uncertainty which makes it difficult to sufficiently allocate budget to the road network contracted under periodic or routine projects. Moreover, the findings also revealed that the activity unit rate used for routine and periodic maintenance was developed in early 2000 E.C and has not been revised since and has been a bottleneck for establishing proper maintenance costs for a specific project. The overall maintenance contracting practice implemented by maintenance agencies can be regarded as unsatisfactory.

A strong road infrastructure system is the backbone of poverty eradication and maintaining a sustainable socio- economic structure in developing countries. PBMC is a new concept designed to resolve the problems related to traditional methods of contracting and has significant potential to improve the maintenance and management of road infrastructure. PBMC reflects a long-term trend in changing the focus of upper management and maintenance managers to outcomes, especially those that are customer oriented.

The study revealed that if properly implemented, PBMC can be an alternative solution for the current road maintenance practice as it results in cost saving and improved condition of roads. Evidences also suggests that PBMC results in better outcomes at lower cost with less risk and more financial predictability for highway agencies.

Though, it is feasible to implement PBMC for Ethiopian road maintenance industry, the following points can be taken as major drawbacks that can be encountered during implementation stage in the current maintenance practice. These are:

I. Significant cultural change required both by the contractor and the agency in order to adapt from input method to outcome based method of maintenance.
II. Insufficient contractor capacity in the country.
III. Contractors fear of risks
IV. Incomplete and insufficient inventory condition data
V. Bidders in ability to find sufficient competition.

5.2 Recommendations

Based on the findings of the research, the following recommendations were forwarded towards the current contractual practice and study of PBMC in Ethiopian federal roads.

I. Proper road maintenance contracting system need to be established by ERA
II. It would be vital to use hybrid contract which include performance and method specifications, payments based on both lump-sum and unit prices, maintenance and rehabilitation work, so as to minimize difficulties occurred in transforming from method to performance contracts.
III. Capacity building and training programs would be useful for PBMCS. A variety of audiences and formats could be addressed, including maintenance organizations of transportation agencies, contractors, subcontractors, in house staff and contractors working together, and contractor-subcontractor interaction
IV. There is a need to revise road maintenance activity unit rates which was developed in 2008 and is still used for the current maintenance activity.
V. There is a need to change maintenance organizational structure, acquire a new set of skills and expertise to enable the road agency staff to effectively develop and manage PBMCs.

5.3 Future Research Needs

I. Research is needed on methodologies for evaluating cost savings of performance-based contracting. This research could include an analysis of administrative savings.

II. Research could be conducted to explore performance measures and measurement protocols concerning LOS for different types of maintenance assets and operations.

III. Further research can be carried out on the challenges to implement PBMCs successfully in the developing countries.

IV. More research is required on how to implement an effective benchmarking process that can be used to compare road agency and contractor costs with respect to performance, identify best performers, and determine the corresponding best practices.

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Annex-1

Interview Schedule

Introduction

This interview schedule is prepared to obtain information from key informants with semi structured questions. The information was required for the academic research entitled "**Study of Performance Based Road Maintenance Contracting System for Ethiopian Federal Roads**" which is being conducted as partial fulfillment of MSc in construction technology and management. The main objective of the research was to examine current contractual practice in relation to the status of the road conditions and make recommendations based on the findings.

The schedule consists of four sections with a total of 21 questions. Section one contains general questions about the informants. Section two, assesses the current practices of road maintenance contractual system at Federal level. Section three examines performance based contracts for Ethiopian federal roads. Section four investigates the in implementing the PBMCs. Section five is left for general comments on the research.

Your response, in this regard, is highly valuable and contributory to the outcome of the research.

All feedback will be kept strictly confidential, and utilized for this academic research only.

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Addis Ababa, Ethiopia

I. General Profile of the respondents

1.1 Name_____

1.2 Position_____

1.3 Organization_____

1.4 Address_____

1.5 Educational status?

1. BSc 2. MSc 3. Others specify _____

1.6 What is your field of specialization?

1. Civil Eng.
2. Transportation Eng.
3. Highway Eng.
4. Geotechnical Eng.
5. Others specify

1.7 How long have you worked in the road sector?

1. 0-5 years 2. 6-10 years 3. 11-15 years 4. ≥15years

.

II. Questions for Current Road Maintenance Contractual Practice

2. Several literatures reveal that there are two main types of contracts that road agencies choose from when contracting road maintenance, these are; traditional unit rate and performance based contract.

2.1 What type road maintenance contracting system do you use for federal road maintenance?

1. Traditional unit rate contracts 2. Performance based contracts 3. Others

2.2 Do you find the current contractual practice Implemented in the country satisfactory?

1. Yes 2. No

2.3 If you answer is No, what are the impediments of the current contractual practice?

Please specify ----------

2.4 Is your contractual unit rate price for road maintenance established through proper consideration of the current construction costs?

1. Yes 2. No

2.5 If your answer is No, would you like to share your experience on how you deal with activity unit rates that may have an Impact on road maintenance costs?

_____

_____

_____

2.6 Do you find the current status of roads contracted under routine and periodic maintenance satisfactory?

1. Yes 2. No

2.7 Do you think the current activity unit rates in place is one of the reasons for the allocation of maintenance budget for routine and periodic maintenance projects?

1. Yes 2. No

III. **Questions for Performance Based Road Maintenance Contracting System**

3. Performance based maintenance contracting (PBMC) is a contracting method that provides incentives and /OR disincentives to the contractor to achieve desired out comes or results in its purest form PBM does not detail how, when, or, where, to do the work, but sets performance to be achieved.

3.1 Do you use PBMCs for federal roads?

1. Yes 2. No

3.2 If yes, what are the results achieved by using PBMCs? Please specify_____

_____

3.3. Studies conducted on the countries who have previously implemented PBMCs reveal that road maintenance community has benefited from cost saving and improved road

conditions? Do you think the current road maintenance industry is suffering from high cost and poor condition of road?

1. Yes 2. No

3.4 If your answer is Yes, what are the solutions proposed torwards decreasing maintenance cost and improving road assets? Please specify

_____

_____

3.5 Evidences suggest that PBMCs allows highway agencies to fully control expenditures. Does your company encounter any problems in controlling expenditures?

1. Yes 2. No

3.6 If your answer is yes, please specify

_____

_____

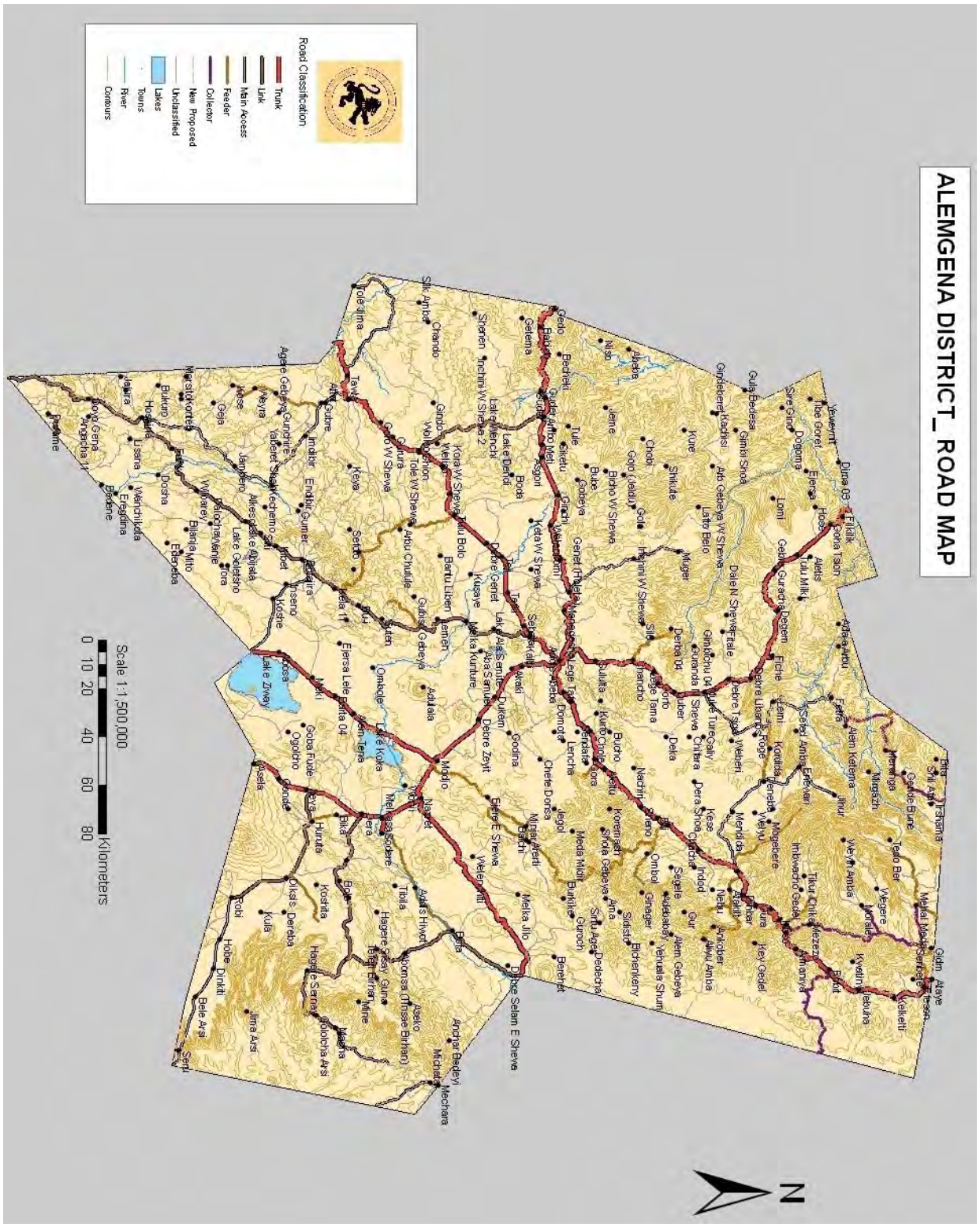
IV. Questions for major draw backs in implementing Performance Based Road Maintenance Contracting System

4. Studies conducted on different countries revealed that countries implementing PBMC has its own challenges. Which of the following are the draw backs in Implementing PBMCs in the case Ethiopia?

1. Cultural change required
2. Inadequate experience
3. Insufficient contractor capacity
4. concern overall life cycle cost increment
5. Fear of risks
6. Incomplete and insufficient inventory and condition data
7. Lack of legal authority
8. Lack of training
9. Inability to achieve contractor's competition
10. Fear PBMCs results in large number of staff having to leave government.

Thank you for your time!

Annex 2: Geographical Road Maps of RMPs



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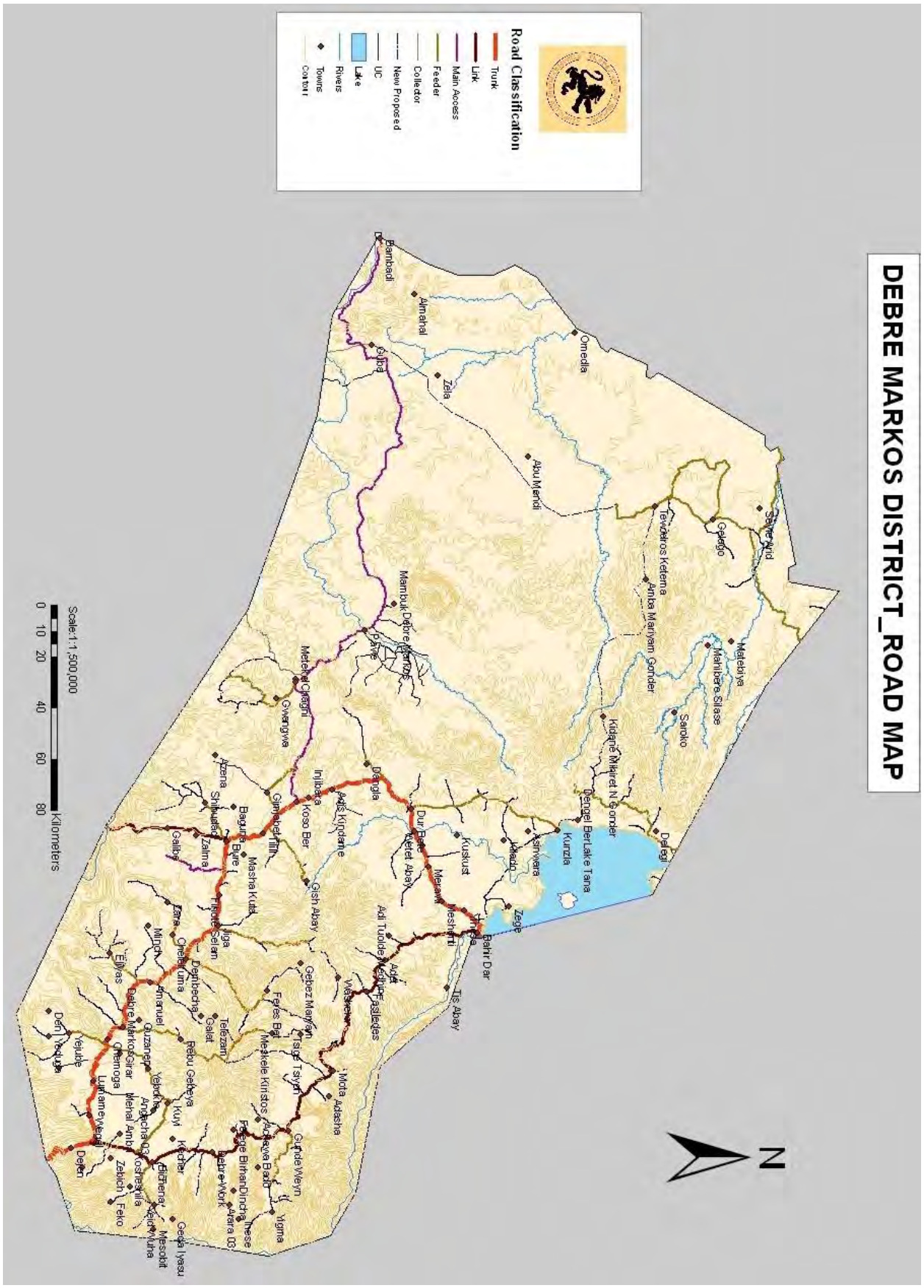

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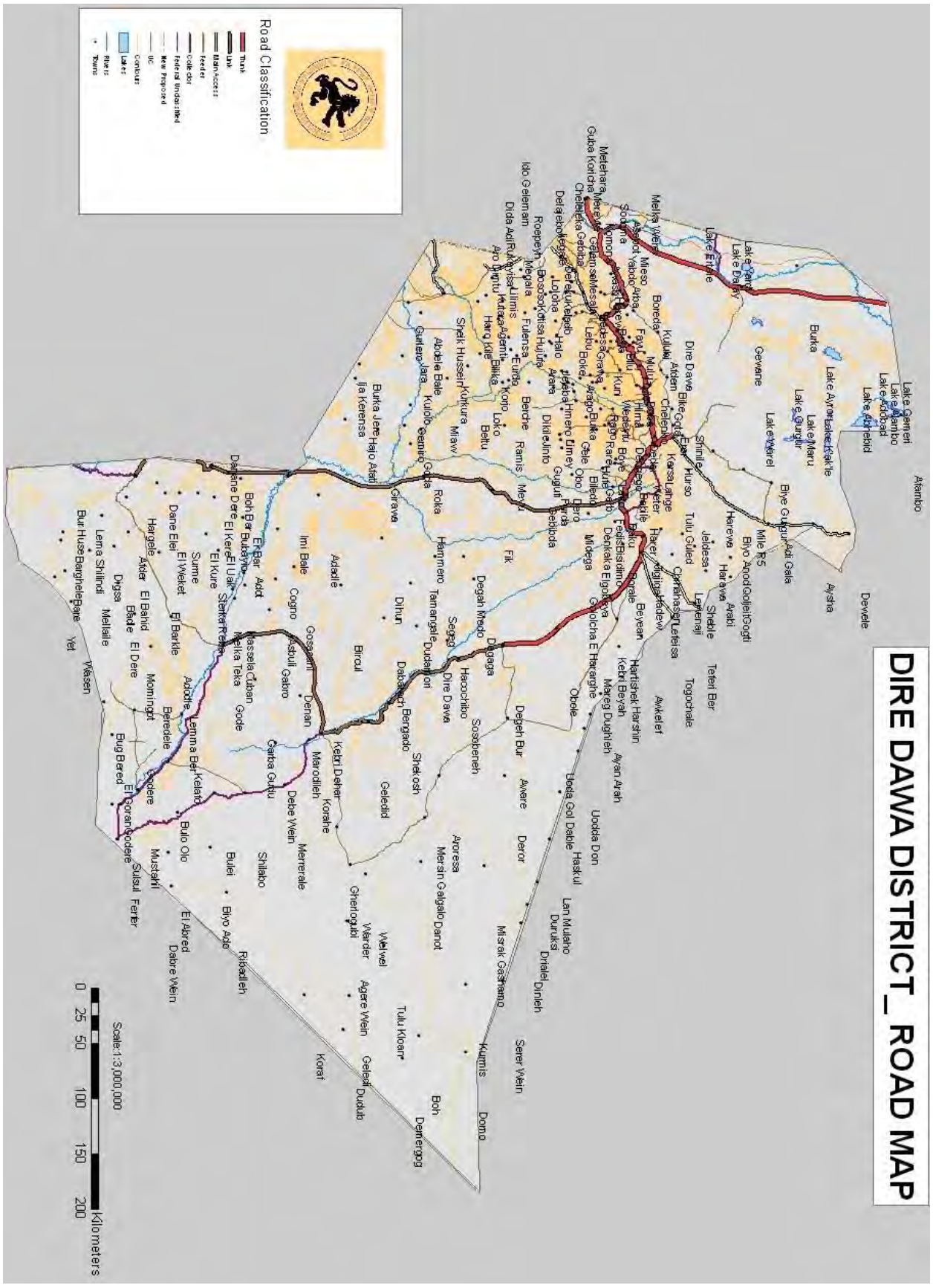

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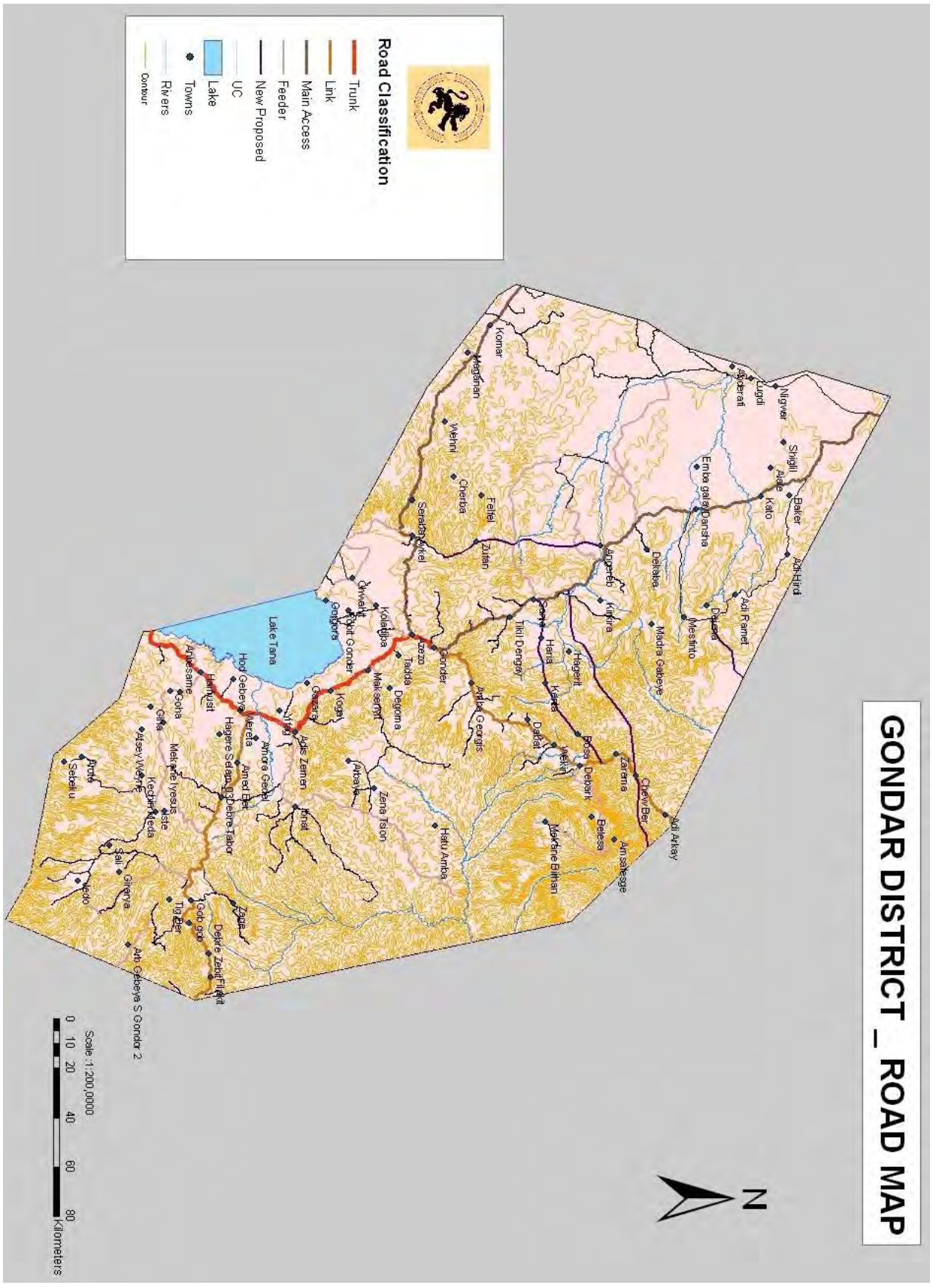

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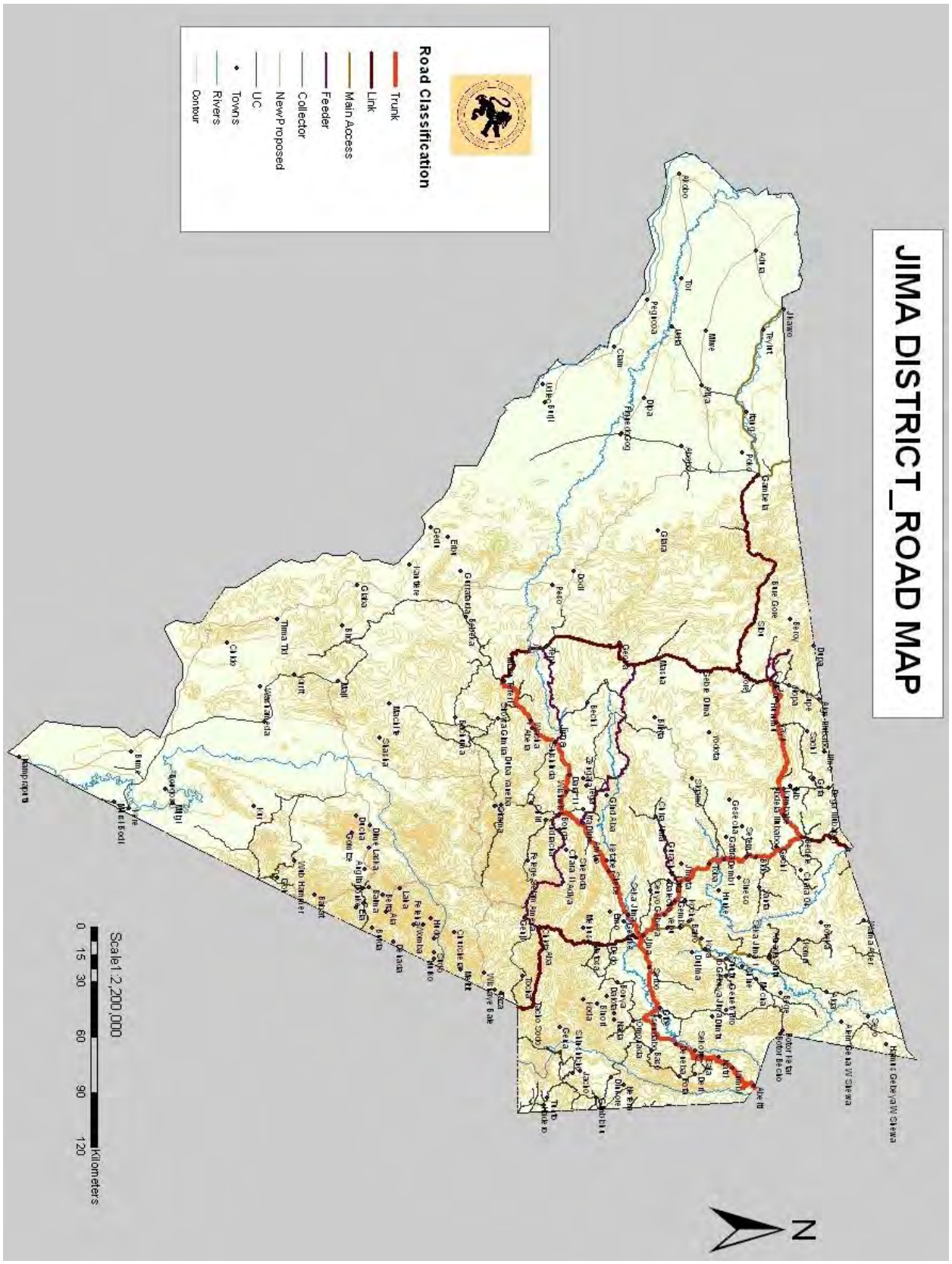

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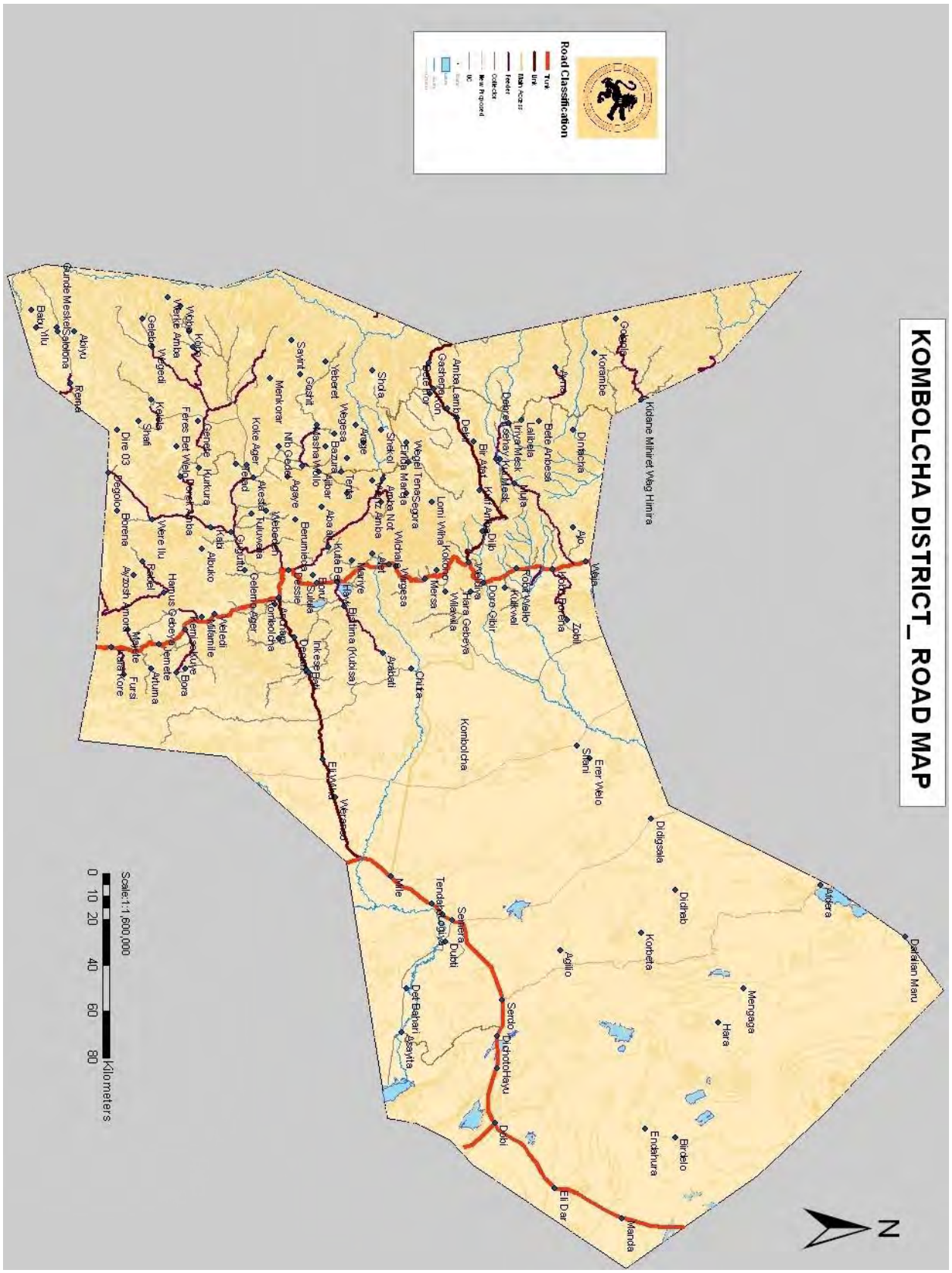

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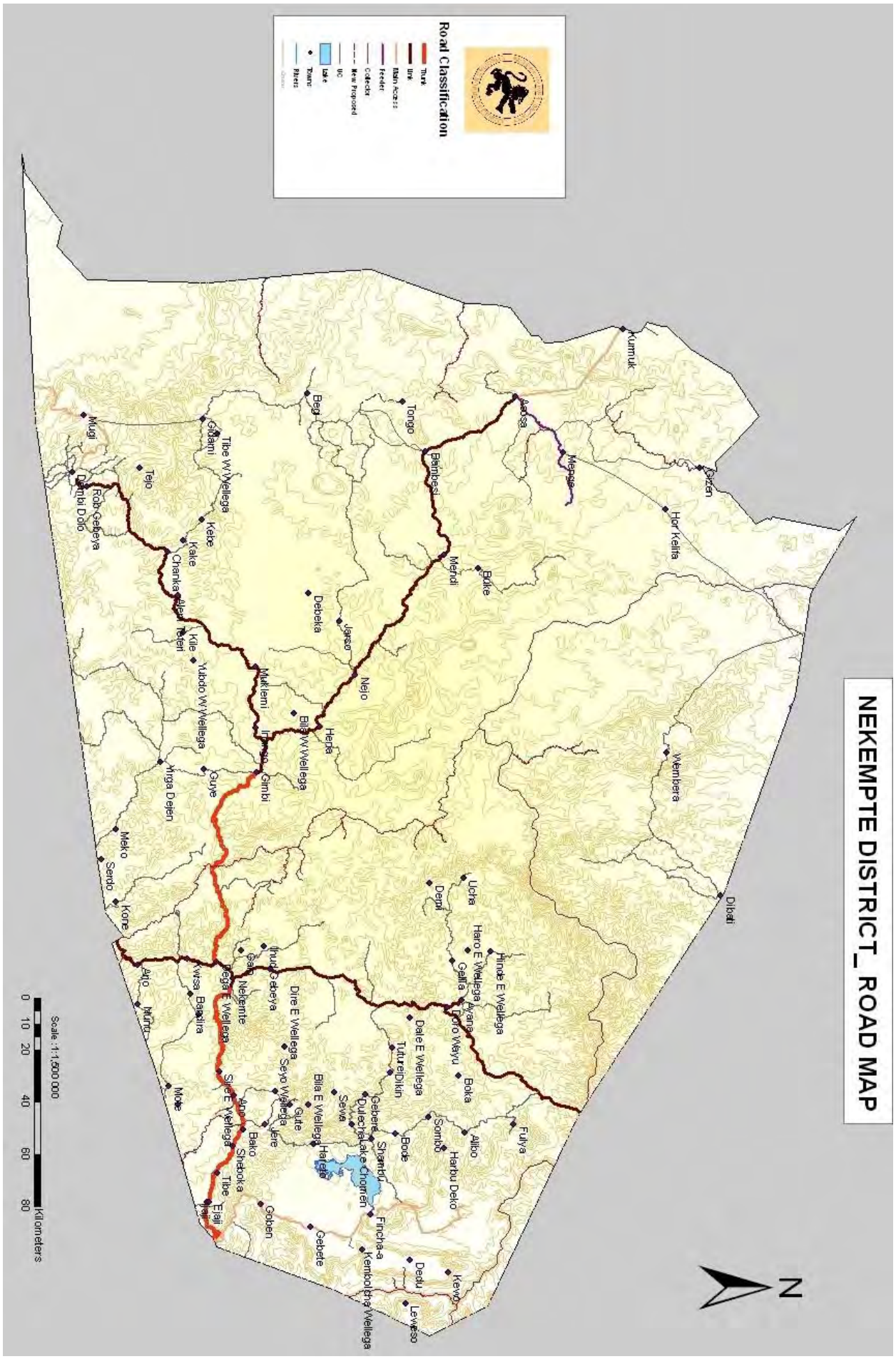
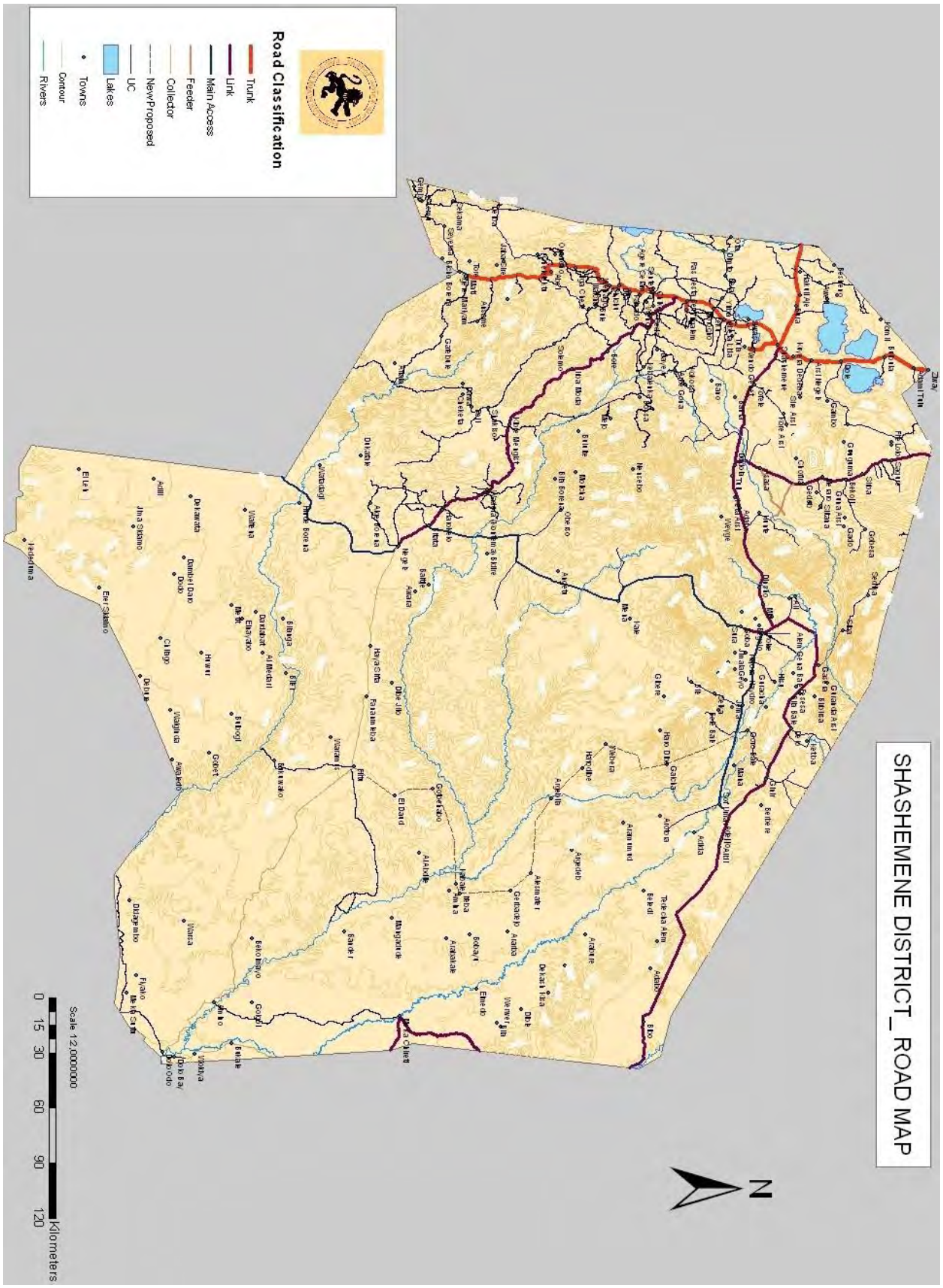
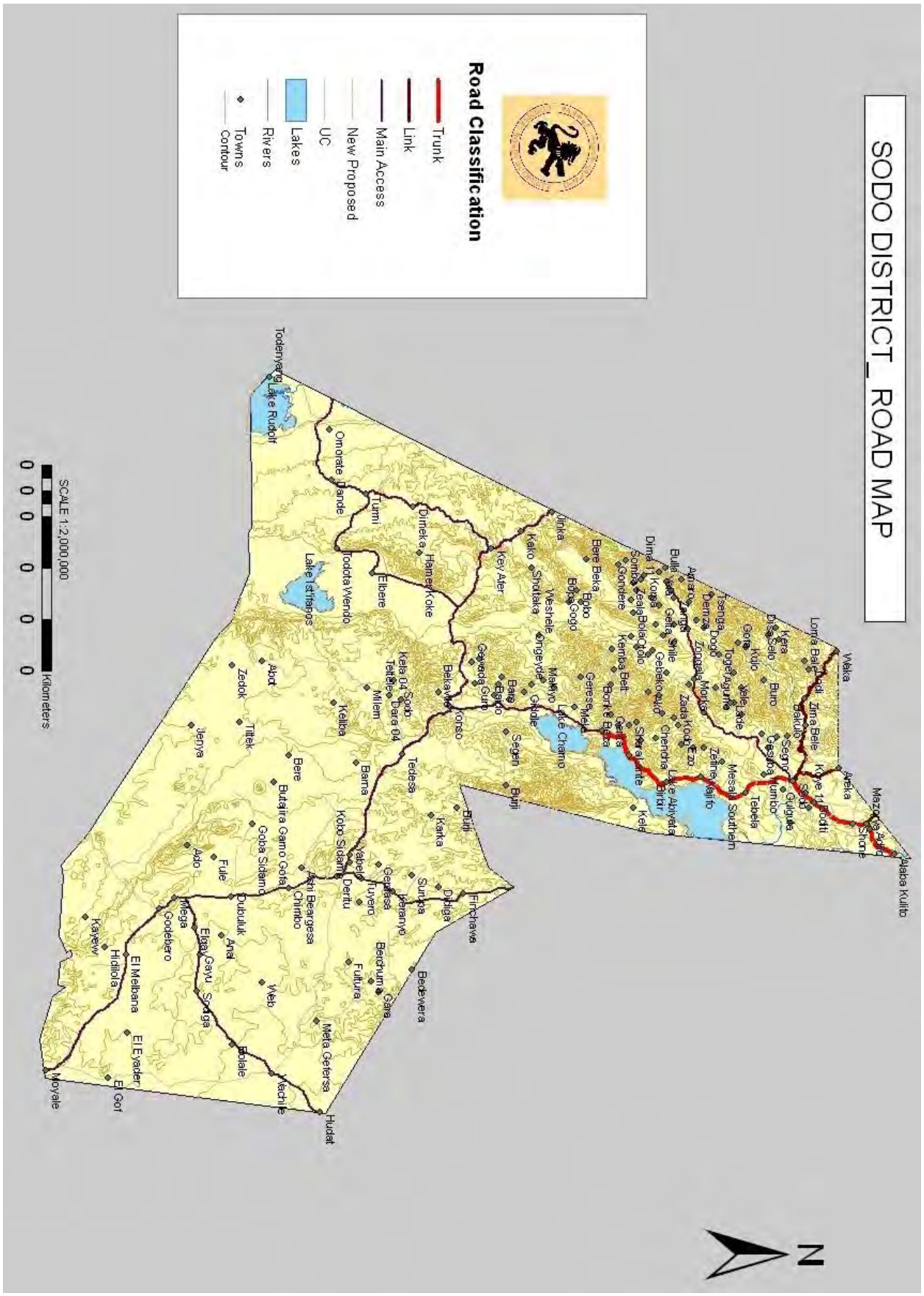
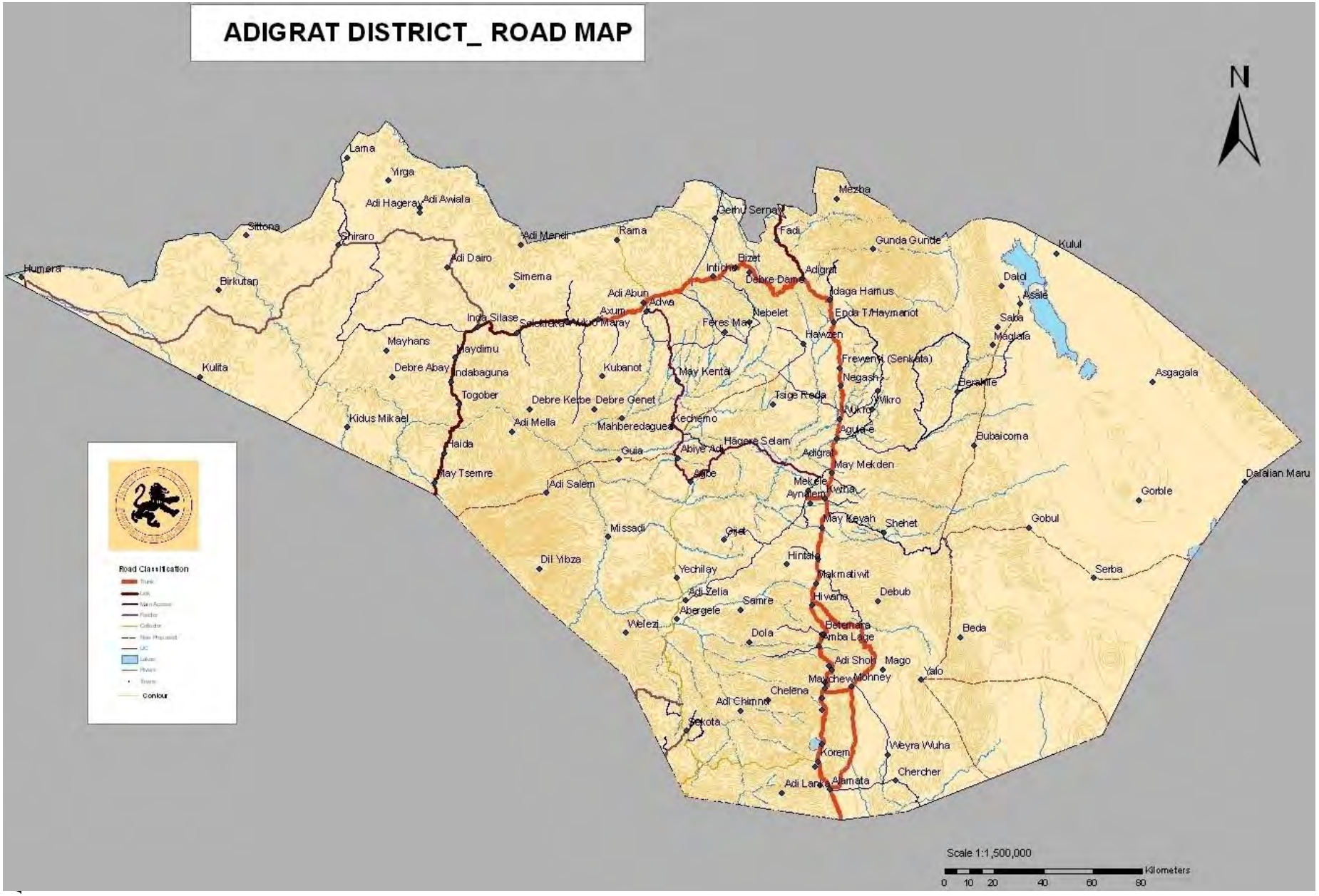


Annex 2: Geographical Road Maps of RMPs



Annex 2: Geographical Road Maps of RMPs




ADIGRAT DISTRICT_ ROAD MAP
N
Lama
Yirga
Adi Hagera
Adi Awiala
Sittona
Shiraro
Adi Maneli
Rama
Mezba
Gehu Serna
Fadi
Gunda Gunde
Kulul
Humera
Birkutan
Adi Dairo
Simema
Intichio
Bizet
Debre Dame
Adigrat
Dalol
Asale
Adi Abun
Adwa
Axum
Indabaguna
Nebelet
Feres Mai
Idaga Hamus
Enda T/Haymanot
Saba
Maglala
Hawzen
Mayhans
Maydimu
Debre Abay
Kulita
Kubanot
May Kental
Frewenti (Senkata)
Negash
Asgagala
Beraktle
Togober
Debre Kebbe
Debre Genet
Tsige Reda
Wikro
Kidus Mikael
Adi Mella
Mahberedague
Kechemo
Agula-e
Haida
Guia
Abiye Adi
Hagere Selam
Adigrat
Bubaicoma
May Tsemre
Adi Salem
Adge
May Mekden
Mekele
Aynalem
Kwiha
Dalalian Maru
Gorble
May Keyah
Shehet
Gobul
Missadi
Ojet
Hintalo
Dil Yibza
Yechilay
Makmatiwit
Serba
Adi Zelia
Hiwane
Debub
Samre
Abergele
Welezi
Dola
Betemara
Amba Lage
Beda
Adi Shoh
Mago
Yalo
Mohney
Chelena
Adi Chimno
Sekota
Weyra Wuha
Korem
Chercher
Alamata
Adi Lana
Road Classification
Contour
Scale 1:1,500,000
Kilometers
0 10 20 40 60 80