UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

EFFECT OF IRREGULAR ROAD MAINTENANCE ON THE LIFE PROJECT CYCLE COST

(CASE STUDY OF GOVERNMENT URBAN ROAD IN ACCRA MUNICIPALITY)

BY

AGYEMAN BANNERMAN

AUGUST, 2016

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A Dissertation in the DEPARTMENT OF CONSTRUCTION and WOOD TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, Submitted to the School of Graduate Studies, University of Education, Winneba – Kumasi in Partial Fulfillment of the Requirement for Award of the Master of Technology Education (Construction Technology) Degree.

BY

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AUGUST, 2016

DECLARATION

CANDIDATE'S DECLARATION

I, Agyeman Bannerman, declare that, this dissertation with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE…….…….....

DATE…….....……..

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of dissertation laid down by the University of Education Winneba.

SUPERVISOR'S NAME: Dr. P. P. Yalley

SIGNATURE……

DATE…….....…

DEDICATION

This work is dedicated to my **wife and children** who through their understanding and encouragement, has given me support throughout my two years at the University of Education, Winneba-Kumasi Campus.

ACKNOWLEDGEMENTS

I wish to thank the Almighty Lord for making it possible for me to undertake this research work. My deepest appreciation goes to my supervisor Dr. P. P. Yalley for their diligent effort in instructing and guiding me throughout the writing of this research work.

Finally, I wish to express my sincere thanks to all those names I cannot mention especially those who helped me in one way or the other; I say may God bless you all.

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ABSTRACT

The purpose of this study was to improve key stakeholders' understanding of the effects of irregular road maintenance on urban road project costs. The study adopted the survey research design. Quantitative research method was used to gather primary data. The population for the study was 23 consisting of Urban Roads Management experts at the Urban Roads Department in Accra specifically Okaikoi –North, Okaikoi –South, East Ayawaso and Osu-krotey. The researcher used purposive sampling technique to select 23 respondents for the study. Interview guide, questionnaires and observations were used to gather primary data. In analyzing the data collected, both the descriptive and quantitative methods were used. Tables, frequencies, percentages, Pie and bar charts were used to present and analyze data collected from the field. The key findings of the study concluded that there seems to be little acceptance that constant care of a road would result in prolonging the time when a major input of funds is required to solve the problem caused by the lack of routine maintenance. The social and economic impacts of urban roads are well established. Urban roads improve urban access, which facilitates marketing, schooling and health services. Better access provides the opportunity for increased income and employment opportunities and can also contribute to the alleviation of poverty. Still, maintenance of urban roads is seriously neglected in Ghana. Areas with poor road access are generally more disadvantaged than areas which are better served. Investments in rural roads can therefore often be justified from both a socio-economic and a poverty reduction point of view. The study recommended that, the government and development partners should invest in routine road maintenance activities to sustain the Accra Metropolis road network. The Ministry of Roads and highways should conduct periodic road maintenance

seminars, forums and workshops to enhance the expertise of the road maintenance engineers.

CHAPTER ONE

INTRODUCTION

1.0 Background to the Study

Road transport is by far the dominant carrier of freight and passengers in Ghana's land transport system. It carries over 95% of all passenger and freight traffic and reaches most communities, including the rural poor (National Transport Policy, 2008). Maintenance of transports assets is critical to achieving desired accessibility, affordability, reliability and safety.

In response to the road travel needs of the citizenry, governments and private individuals are putting up roads to ease Traffic Congestion problem facing people of Ghana. However much of a cliché it may sound, it is much cheaper to maintain existing national assets than to procure new ones. In an apparent disregard for this principle, it appears much attention is given to the development of such new roads and other facilities rather than maintaining existing ones. (Kumar *et al.,* 2007).

As Seeley (1974) observes, all elements of property deteriorate at a greater or lesser rate depending on the materials used, method of construction employed, the environmental condition in which the roads is situated and the use of the roads.

Maintenance is difficult, a complex system in the life time of road projects. Ghana has a total land area of 238,537 sq. km with a road network inventoried in 2003 to be over 50,000 km (Acquah and Acquah, 2005). This represents about 0.15% of the total land area of the country. The road sector is controlled by the Ministry of Roads and Transport which is supported by three agencies.

Road maintenance is essential in order to preserve the road in its originally constructed condition, protect adjacent resources and user safety, and provide efficient, convenient travel along the route. Unfortunately, maintenance is often neglected or improperly performed resulting in rapid deterioration of the road and eventual failure from both climatic and vehicular use impacts (Caruthers *et al.,* 2008). All these agencies undertake a mixture of routine and periodic maintenance, reconstruction and rehabilitation.

1.1 Statement of Problem

Issues regarding urban roads accessibility in Sub Saharan Africa remain a challenge towards poverty reduction and achievement of sustainable development despite their importance towards economic development. Roads are of vital importance in order to bring development of areas they serve and make a nation grow and develop (Ikiara *et al.,* 2000). Asif (2012) supported the argument that, good maintained roads also will enhance poverty reduction by improving access between regional and rural communities and, ultimately, enhancing socio-economic growth and development. KeNHA (2007) is in agreement that," if nothing is done, roads with a design life of decades can need replacing or major repair work after just a few years. Roads deteriorate very quickly if not well maintained. Development and maintenance of physical infrastructure are keys to rapid economic growth and poverty reduction. Production costs, employment creation, access to markets, and investment depend on the quality of infrastructure, especially transport.

Ghana Highway Authority (GHA) responsible for the administration, control, development and maintenance of the trunk (inter urban) road network, some town roads and related Facilities in Ghana totaling 14,047km (Addo, 2000).

The road sector currently has a network size of about 71,063km across the country. The paved network is 30% while the rest are unpaved (GSGDA, 2010-2013). As at the thematic years under review 2014 and 2015 respectively a total percentages of government budget of 52% and 49 % was allocated for the road sector. Out of these percentages allocation 28% and 25% was allocated to urban road as Government budget. But only 33% and 30% was released for maintenance of urban roads but the remaining 67% for the thematic year of 2014 was not released (MFEP, 2013).

As indicated in the above, a funding gap of GH¢4,173million (67%) needs to be filled to ensure the execution of the programmers and projects (SMTDP, 2013). The sector of urban road covers wide range of road that can be located within the city. This unit is in charge of all the links that are located in the metropolis. It provides platform where large roads which can be understudy for the purposes of establishing the effects of irregular road maintenance of investment cost of road. The situation in region concerning the road condition is not only urgent, it is critical. It is important to know the costs involved in urban road maintenance and the costs of not maintaining urban roads. On account of the important of road construction activities, several studies have been conducted to evaluate impacts of road maintenance on government projects (Harral and Faiz 2005; Liautaud, 2001; World Bank (2007). But one obvious impact they did not include in their studies was reflect of irregular maintenance of urban roads on the life cycle cost. In order to address these limitations and expand the existing literature on "Effects of irregular maintenance of roads on life cycle project costs", hence the purposes of this present study.

1.2 Aim of the Study

The main aim of the study was to investigate the effect of irregular maintenance on project life cycle cost, using Government urban roads in Accra Municipality as a case study.

1.3 Research Objectives

The objectives of this study aim at:

1. Assess the state of roads in Accra Metropolitan Assembly (A.M.A)
2. Evaluate the maintenance plan in Department of Urban (DUR)
3. Assess the life cycle cost of the roads.
4. To find out the source of funding and maintenance budget of DUR

1.4 Research Questions

The fundamental questions to be addressed in this study are:

1. What are the states of roads in Accra Metropolitan Assembly (A.M.A)?
2. What are the maintenance plans of Department of Urban roads (DUR) in Accra Metropolis?
3. What is the life cycle cost of the road?
4. What is the maintenance cost and how are they funded?

1.5 Significance of the Study

This study is valuable in terms of its contributions the understanding of the potential strain the gap between the current practices of road maintenance projects in Ghana can put on the economy as a whole. It also gives a detail about the post-construction management within the road transport sector which will improve policy formulation

and decision-making with respect to constructing and managing urban roads. Additionally, the Ghanaian economy is migrating from an under-developed economy, hence there is the need to support this growth with appropriate road transport systems, of which urban roads is an important element. In short, the study will contribute significantly to:

1. The understanding of urban road maintenance issues in Ghana.
2. Existing literature on road construction projects planning.
3. Contribute to knowledge to academic institution such as tertiary institution and other researchers.
4. Policy makers can used it to formulate policy and make informed decision

1.6 Scope and Limitations of the Study

The limitations are those conditions beyond the control of the researcher that may place restrictions on the conclusion of the study and their application to other situations. The problem under consideration cuts across the entire country but due to time and financial constraints, the study was limited to selected government roads in the Accra Metropolis. As such, all samples taken in the course of this exercise were from selected public sector institutions in Accra, specifically Urban Roads Department. There are several other towns and cities that could have been included to make the results more representative.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Going through this chapter, the theoretical concepts for this study are introduced and explained to provide the needed background for the purpose of this research. Also, some relevant concepts used as the basis for evaluating the current urban road management practices in Ghana are introduced and further explained. In essence, this chapter introduces the theories on which this research paper is based. This section focuses in particular on road maintenance under the following headings:

Road Maintenance –An Overview

Concepts and Definitions

Road Maintenance Costs

Conclusion

2.1 An Overview of Road Maintenance

The importance of good road maintenance cannot be overstated. Recent years have seen a significant change in most countries to the means by which road networks are maintained and this has reflected broader political and economic developments which have occurred. Increased involvement of the private sector to carry out road maintenance management activities has mirrored a general desire to reduce the involvement of government in 'operational' functions and to concentrate on the 'higher' functions of a client 'enabling' organization (McGillicuddy, 1996).

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 which maintenance activities will need to address.

The Word Bank (2011) is clear on the importance of road maintenance – "Timely road maintenance is important because it sustains the quality and safety of the road in a condition close to the original design, and minimizes the road user costs". It is also cheaper to regularly maintain a road in whole life cost terms, than to endure an ongoing cycle of un-managed deterioration and reconstruction. The impacts of inadequate maintenance can be felt immediately on the safety of the road and on vehicle performance. The World Bank's note on "Why road maintenance is important and how to get it done" gives a helpful overview of the arguments for timely road maintenance and advice on good practice. Maintenance is thus organized as a preventive measure and for this reason it starts from the day the road improvement works are completed.

The effect of regular and timely maintenance is to ensure 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 the World Bank (2011), the yearly cost of maintaining a road is a small fraction of the investment cost, usually some 2-3% for a major paved road and 5-6% for an unpaved rural road. The economic logic for effective preventative maintenance is undeniable. It can indeed be argued that the construction of roads, whilst consuming large amounts of money, is of limited importance if there is no effective maintenance.

Maintenance requirements depend upon a number of external factors such as traffic, terrain, soil types and climate (Gyamfi *et al.,* 1992). The need for maintenance is also very much determined by the original technical designs applied during the construction of the road, and the quality of the works carried out during the construction works. Depending on these parameters, it is possible to devise maintenance solutions and corresponding management systems which optimize maintenance costs and efforts.

Timely and regular maintenance requires securing sufficient funding before repairs and maintenance become an urgent issue (Donnges *et al.,* 2007). The most effective form of maintenance is achieved when an organization is capable and prepared to carry out appropriate interventions at an early stage of deterioration and thus limit the extent of damages. This implies that the responsible authority is furnished with the necessary human and financial resources to effectively manage all facets of the maintenance works. Transport infrastructure - roads, railway tracks and stations, ports and airports, and even the most basic urban facilities - all require maintenance, sometimes known as 'conservation'. Maintenance ensures that the asset continues to function as designed or intended, and meet the required quality standards throughout its anticipated lifetime. It can also extend the life of the road beyond the original 'design life' (Donnges *et al.,* 2007).

No matter what technical designs are chosen, all roads, from major highways to local gravel roads, require regular and timely maintenance in order to secure a reasonable lifetime on the construction investment. Attempts to find technical designs which are maintenance-free are disillusions and in the long run only prove that lack of maintenance leads to accelerated rates of deterioration (Potter, 1997).

For most countries, there has been a gradual increase in awareness &the need to make better use of road sector budgets in maintaining the existing networks. This has been stimulated by the fact that funds have usually been inadequate to perform the optimum maintenance required and so initiatives to improve both the effectiveness ('doing the right work') and efficiency ('at the best value') of road maintenance operations have been sought.

In Africa, the rehabilitation of the road network, and the buildup of institutional, financial and technical capacity for its continued maintenance, are among the most critical challenges confronting transport planners and policy makers (Bishanga and Mgalula, 2000). In a bid to meet growing developmental needs in the 1960s and 1970s, many African countries expended considerable sums to expand their road networks. At the same time the resource base for maintaining existing and newly created road assets was squeezed and the performance of the network failed to match expectations (Bishanga and Mgalula, 2000).

Most countries relied on regular recurrent budget funding through the Treasury to finance maintenance – the budgeted amounts normally fell well short of requirements and what had been budgeted was rarely fully allocated. Some countries sought to set up Road Funds (RFs) (referred to as the “first generation” road funds) usually as a line item in the national budget (DFID, 2002). This represented a type of “earmarking” of government revenues to finance a service, administered and largely delivered by government departments and allocated according to more or less pre-defined priorities. The RFs generally fell well short of their goals as manifested in poor governance (diversion and inappropriate usage of funds, lack of auditing), poor collection and

disbursement and inadequate contribution for yearly maintenance of the country's road network (DFID, 2002).

2.1.1 The Road Maintenance Situation in Ghana

In Ghana, the combined effects of population growth, urbanization, and motorization are compromising the efficiency and durability of urban roads (Owusu-Acheaw, 2011). Records available on urban transport indicate that private cars and taxis take up 70 percent of the road space and convey only 25percent of commuters, while the remaining 30 percent of road space is taken up by buses and “trotro” (minibuses), conveying 75percent of passengers (Urban Roads Department, 2012). Clearly a bus can undertake the work of several taxis and private cars.

The management of roads in Ghana is the responsibility of the Ministry of Roads and Highways, which performs this duty through four (4) main departments; namely the Department of Feeder Roads, Department of Urban Roads, Ghana Highway Authority and the Ghana Road Fund Secretariat (Ministry of Roads and Highways, 2010). The first three institutions are responsible for the pre and post construction activities related to all feeder roads, urban roads and highways respectively. These departments of the Ministry manage their designated roads through the various metropolitan, municipal and district assemblies within the country (Urban Roads Department, 2012).

To manage the road maintenance challenges in Ghana, past and present governments have put in measures to remedy this situation. An example of such an effort can be seen in the press statement released by the Ministry of Roads and Highways in February, 2010 (Urban Roads Department, 2012). In this statement, the government outlined its

projects and programs regarding road networks in the country, which included road maintenance. Contrary to the outlined projects, very few of these projects were undertaken and these constraints were attributed to the lack of funds in the roads fund (Government of Ghana Official Portal, 2011). As a result, although governments, past and present, have made some effort, roads are still plagued with potholes, cracks, eroded sections of the roads as illustrated in figure 2.1.

Figure 2.1: The State of Urban Roads in Ghana

Source: Google Images of Urban Roads in Ghana Retrieved April 2013.

The source of funding post construction management activities for roads is the Ghana Road Fund which was established by law in the year 1997 (Dua-Agyeman, 2006). Almost a decade after the establishment of this fund, an audit report of the fund shows a negative balance of ¢37 billion (Dua-Agyeman, 2006). As a result of the fund's inadequacy to support the roads sector, the sourcing of funds from various international bodies has become the order of the day (Kumasi Metropolitan Assembly, 2011).

Although research by the World Bank Group (2008) has shown that transportation and its related sectors play a very significant role in social development, it has also been established that it contributes to the overall development of the economy. The lack of funds limits the performance of many activities and that of road maintenance is no exception.

Economic data from Trade Economics (2011) on Ghana indicates that transportation in Ghana is largely by vehicular movement which occurs on roads. The 2005 budget of Ghana indicated that 3% of the country's budgeted revenue of about ¢35,672.5 billion, would be allocated to the road fund in the year 2006. This emphasizes the fact that, though the funds allocated to the Road Fund may not be enough, some remittances are made to the fund annually. It is expected that existing roads would be maintained properly so they do not develop potholes and cracks, yet it seems this is not being done. Observing the current state of roads in the urban centers, a question is raised as to what the ministry is doing about it.

It is important at this point to make a clear distinction between maintenance and repair works. Proper maintenance is clearly time linked, and to be efficient is carried out before major damage takes place. This involves activities relating to supervision and monitoring of the road assets even while they are still in good condition. It also requires that road authorities are sufficiently responsive and capable of taking action when it is required - as opposed to a response in terms of repairing the road when access has finally been cut off.

2.2 Definition of maintenance

According to Haas and Hudson (2008) the definition of maintenance varies among agencies. In a physical sense, maintenance consists of a set of activities directed toward keeping a structure in a serviceable state. For pavement, this includes such work as patching, crack, filling and so on. Following are some definition of maintenance from different sources.

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

- Maintenance involving repairing work
- Maintenance involving prevention work.

Repairation 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.

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

Therefore, maintenance the road is important to make sure the traffic flow smoothly. But most of the developed countries are faced with high maintenance cost on the aging transportation highway. Fwa (2006) highlighted that highway maintenance can broadly define 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 maybe done if these appear to be the most cost – effective actions

in the long terms. Maintenance could be emergency, remedial (routine or recurrent) and preventive (periodic) type.

Road maintenance must be planned, managed, design and executed. Planning and management are done by means of maintenance management systems and procedures. These system and procedures are normally different from a pavement and bridge management systems since it do not focus on long term and strategic repair and upgrading issues. Relevant pavement and bridge can be identified for protective and preventive actions as part of a road maintenance program. On time maintenance is extremely important.

Dipak (2005) conduct 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

i. Agency cost: Capital cost of construction and maintenance of the facilities over their design life; and
ii. Road User Cost.

Regarding to Reginald (2006), 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 the Armstrong (2004), some of the advantages of the involvement of maintenance department in early stage are it would able to check the practicability of the design details, the suitability of patent joint, anticipate leaks, staining, expansion joints, and many other things that can prevent further defects in the future caused by miss-design.

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.

2.2.1 Function and Value of Maintenance

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

2.2.2 Function of Road Maintenance

Maintenance works are done to achieve desired goals determined during stages. The main functions in maintaining the roads in a condition that gives good service and maximum safety to the travelling public. This is achieved by keeping the road free of disconcerting physical defects such as potholed pavements, broken pavement edges, loose gravels, stick surfaces, loose and defective bridges decks and other imperfections (Armstrong, 2004).

2.2.3 Value of Maintenance

What is the actual value of maintenance? Building or any other structure that will last longer with proper and continuous maintenance. Poor maintenance may result in the need for reparation, renovation or reconstruction, which will increase in cost at the end of life cycle of the structure. The value of maintenance is discussed from the aspect of:

Time

Compared to time required for reparation and renovation on a structure, maintenance consumes less time, but can produce better quality results. Besides, work qualities for maintenance are also relatively lesser compare to reparation and renovation (Armstrong, 2004).

Cost

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

2.2.4 Structure value and performance

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

2.3 Objectives of Road Maintenance Management System

From the report by OECD Scientific Expert Group (2015), a Road Maintenance Management System (RMMS) is a maintenance management process aimed at systematically and objectively determining pavement quality and programming maintenance actions in response to observed conditions, budgetary constraints and economic optimization (reduction of user costs, optimising agency maintenance cost).

The RMMS is a tool which provides assistance to the maintenance engineer for maintenance programming, implementation and monitoring.

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

i. Provide the economic and managerial framework for deciding the optimal level of maintenance funding and the optimum level of pavement condition nationwide in both the long-term and short-term perspectives;
ii. Provide sound methods for developing annual works programmes and determine resource requirements and budgets;
iii. Allocate funds in a rational and optimised manner to the various maintenance tasks and administrations, particularly under budgetary constraints;
iv. Schedule and perform the work;
v. Monitor the efficiency and effectiveness of the works carried out; and
vi. Evaluate the consequences of delaying or postponing maintenance on future budget needs and the future deterioration of pavement condition.

2.3.1 The Road Maintenance Management Process

It has to be recognized that the process is applied to an existing road network. New construction is generally a small part of the whole, but it does need to be considered within the broader context. The objective is to apply sound knowledge about the road network and its users in order to make the best possible use of resources available and maximise benefits to society. Tillotson *et al.,* (2006) from their study, the main factors needed in road maintenance management process may be summarized as follows.

i. *Inventory.* The purpose of the inventory data is to establish what there is to be managed and where it is located;

ii. *Condition.* The condition of a road needs to be measured or assessed with sufficient precision to enable the need for repair or replacement to be established within a framework of priorities;

iii. *Traffic.* The purpose of the road network is to carry traffic. The amount of traffic on a particular road is an important factor for establishing priorities for repair or replacement. The amount of traffic also contributes to deterioration;

iv. *Deterioration.* All roads deteriorate. It is the rate at which deterioration will take place that needs to be understood as an essential element of a long-term road maintenance strategy;

v. *Costs and benefits.* These are the basis of prioritization within a road management system that aim to *maximise benefits to society* rather than respond to political pressures;

vi. *Resources.* We defined these to be the physical constraints including people and their abilities together with the equipment and materials;

vii. *Budget*. This provides the financial constraint that limits repairs and replacements. The overall budget is likely to be subdivided into allocations for specific sub-networks such as main roads and secondary roads. The RMS should aim to advise on overall budget and allocations within that budget in order to achieve long-term goals;

viii. *Standards and policies.* These reflect the long-term plans and will be developed by predicting the future network condition in response to different budgets, different traffic predictions and different standards and policies; and

ix. *Management information.* Effective decision-making and subsequent audit depend upon the quality of information. All the information involved in the various components of the system must be readily available and in appropriate form for each of the management functions.

According to the report by OECD Scientific Expert Group, the RMMS consists of the following procedures and elements:

i. Data acquisition and retrieval/databank
ii. Data analyses/models, constraints
iii. Optimization making, implementation/annual work schedules
iv. Follow up/ monitoring system

(Haas *et al.,* 2008).

Referring to the Figure 2.1 is the basic elements of a Road Maintenance Management System.

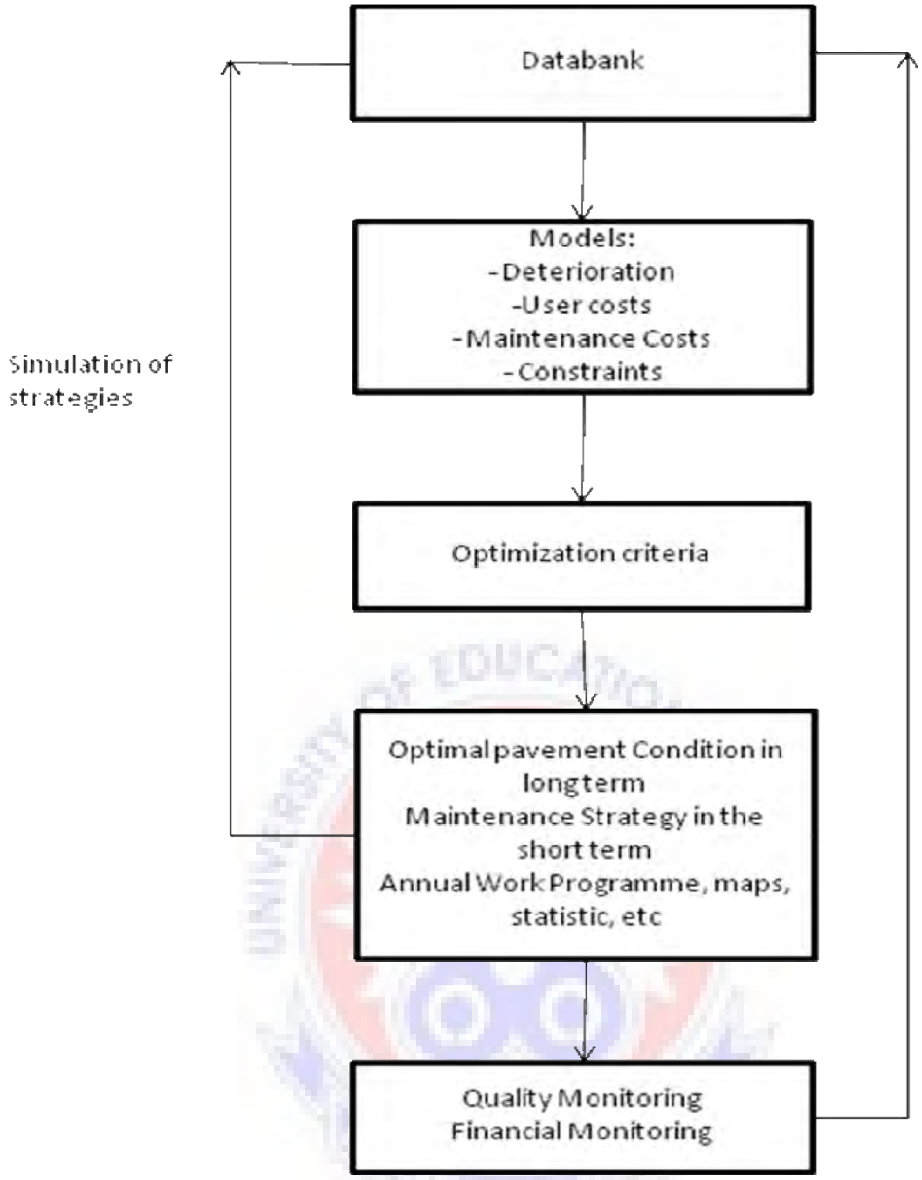

Figure 2.2 Basic elements of a Road Maintenance Management System

(Haas *et al.,* 2008)

2.4 Problems or issues in Road Maintenance

2.4.1 Management System

Haas *et al.,* (2008) have grouped the RMMS related issues and expected outputs at legislative level, administrative level and technical level.

2.4.2 Legislative Level Issues

The legislative level issues as given below are fairly broad in scope and must be recognized by the administrative and technical levels.

i. Justification of budget request;

ii. Effects of less capital and maintenance funding;

iii. Effects of deferring work or lowering standards;

iv. Effects of budget request on future status network;

and v. Effects of increased load limits.

(Haas *et al.,* 2008).

2.4.3 Administrative Level Issues

The administrative level issues are related to the decision making process including budget and programming priorities (Haas *et al.,* 2008).

i. An objectively based priority program to provide justification for budget requests;

ii. A summary assessment of the current status of the network, in graphical and tabular format, based on inventory measurements;

iii. The means for quantitatively determining the effects of lower budget levels, and the budget level required to keep the network in its present state;

iv. The means for quantitatively demonstrating the effects of deferring maintenance or rehabilitation;

v. Estimates of the future status of the network (in terms of average serviceability, condition, safety, etc.) for the expected funding;

vi. Costs of pavement management implementation, including inventory, assignment of responsibility and manpower requirements; implementation staging and schedule, etc; and

vii. Implementation experience of others and documentation of their experience.

2.4.4. Technical Level Issues

From a technical perspective, pavement management involves a large number of issues and questions. In addition, the question and issues faced at the administrative level must be appreciated if technical activities are to be meaningful. The following is an example listing of some of the key questions for this level, involving both network and project considerations:

i. Inventory database design and operation;

ii. Methods and adequacy of inventory database;

iii. Models for predicting traffic, performance, distress, skid, etc., - their reliability, consistency, reasonableness, deficiencies;

iv. Criteria for minimum serviceability, minimum skid, maximum distress, minimum structural adequacy – reasonableness, effects of changes in criteria, etc;

v. Models for priority analysis and network optimization;

Verification of models; vii. Relating project (sub) optimization to network optimization; Method for characterizing materials and using results;

Sensitivity of model analysis results to variations in factors;

(Haas *et al.,* 2008).

2.4.5 Construction Quality control;

Effects on construction and maintenance on pavement performance;

Communication among design, construction and maintenance, within existing administrative structure;

Guidelines of pavement management implementation;

Relating pavement management to maintenance management; and

Improving the technology of pavement management and making use of implementation projects for this purpose.

2.4.6 Improving Road Maintenance Management System

Every system which is practicing now has their strength and weakness together with the improvement in technology. So, for the Road Maintenance Management System was not excluded and need to improve the system time by time. A systematic approach to maintenance management is needed for several reasons:

i. Provide information on the current state of pavements and forecast future condition;
ii. Give objective alternatives for maintenance policies;
iii. Provide a sound basis for resource allocation and optimal use of funds;
iv. Increase the effectiveness of management and provide savings in expenditure; and
v. Provide an objective, rapid and repeatable system for decision making.

Grigg (2005) was concluded that five categories interdisciplinary need to improve in maintenance management.

i. Improve the processes of public works management. In this category four elements of the research problem appear: to improve the effectiveness of

public works managers, to improve the processes of management, to use computer – based tools, and to encourage innovation in management;

ii. Utilize new technologies and materials in road management. This field of technology contains many opportunities for improving the cost effectiveness of services, including instruments to measure performance and predict failures, materials for construction and repair, use of information systems and models to locate problems, and making in situ repairs and tests;

iii. Reduce constraints caused by codes, standards and incentive structures. The specific studies needed, according to that report, were an inventory of federal standards, an analysis of relationships between key federal standards and the related state, local, and professional standard areas; an evaluation of the likely impact of federal standards on the overall cost; and an analysis of the opportunity costs;

iv. Improve the financial capacity for road maintenance management. Four elements to this question include managing finances to make services self-supporting, determining the best roles of the three levels of government, evaluating tax and regulatory policies, and evaluating the results of privatization; and Adjust maintenance management of future pattern of living. Consider trade-offs, and where a level or service cannot be maintained, bite the bullet and reduce it.

2.4.7 Maintenance and Rehabilitation Alternatives

It should be emphasized that properly designed and constructed pavement should provide many years of maintenance free service. Anyhow pavements have finite life, as they are susceptible to wear for several reasons. Many pavement managers use the

pavement condition index (PCI) to track pavement distress over time and apply maintenance treatments. Pavements are usually maintained and/or rehabilitated when the PCI drops to a level of 40-60.

Pavements are costly not only to build but also to maintain. These costs are born by the owner funding the facility. Road users also cost a lot when operating their vehicles on deteriorated and poorly maintained roads. Hence, it is advisable to develop a definite action plan in order to keep asphalt road pavements in a continuous serviceable condition.

The pavement maintenance problem is not simple. Many factors are involved that affect the performance of a pavement. Hence the type of maintenance that will be required for any particular pavement will depend on a number of conditions: the traffic system to which the pavement is subjected; Climate; the structure of the pavement; the quality of construction; the frequency and extent of inspection performed, both during construction and during maintenance; engineering talent involved, maintenance practices; discipline; and money; not necessarily in that order. In general, it is necessary to have the following in order to have the best maintenance program:

1. Organize the maintenance crew with experienced engineering and maintenance personnel.
2. Keep records of all pavement structures that are as precise as possible. These should include records of sub grade soils, sub base and base course, wearing courses and drainage system.
3. Arrange a pavement condition survey program to check and record the pavement condition at regular intervals.
4. Reviews and analyze the condition survey reports systematically.

5. Review the current maintenance methods to make sure that they are being carried out effectively.
6. Prepare work orders for preventive maintenance and to correct distresses investigated during the condition surveys.
7. Establish suitable timetable by prioritizing the projects.
8. Prepare realistic budgets and carry out the maintenance under the most favorable weather and traffic condition.

2.5 Maintenance Programs

Pavement maintenance programmers are required to perform the task of preserving, repairing and restoring different damaged elements of a pavement system to its designed or accepted standard. In general, maintenance of pavements is similar in concept to maintenance of one's home or car. If one doesn't want to repair his leaking roof, it will be further damaged and cause destruction in the house. If one does not want to timely change oil filter, he will certainly pay for the engine in a short time. The same is true to pavement maintenance. The longer one waits to maintain a pavement, the more it will cost to repair. There is no uniform terminology with regard to definitions concerning pavement maintenances and rehabilitation. It varies from country to country and even from authority to authority as well. Maintenance programs can be categorized into routine, periodic and extraordinary maintenances. Each can be discussed in a little more detail as follows:

2.5.1 Routine Maintenance

A routing maintenance program comprises different activities that are to be carried out as frequently as required in order to ensure serviceability at all times .

Major activities include the following:

Clearing roadway pavement, ditches, drains, signs, and safety barriers, etc, as well as grass cutting and tree pruning,

Repair of minor damage to pavement, drainage system as well as any urgent repairs to restore disrupted traffic movement

Maintenances during rainy season such as provision of turn out ditch form storm water, clearing of mud and debris etc.

(Haas *et al.,* 2008).

2.5.2 Periodic maintenance

A periodic maintenance includes operations to be carried out under a long term program within the design period of the pavement. These operations can be divided in to the following two main groups:

Renovation of the wearing surface of the existing pavement that become worn or damaged; e.g. resealing or surface dressing of existing asphalt road.

Restoration of drainage systems, road markings and ancillary items

(Haas *et al.,* 2008).

2.5.3 Extraordinary Maintenance

Extraordinary maintenance consists of activities necessary to restore highly distressed pavements to their original design requirement. The tasks include:

Strengthening and or/reconstruction of a pavement structure which has severely deteriorated (e.g. overlays)

Activities to protect roads against external agents (Such as slope stabilization, retaining structures & flood control measures) (Haas *et al., 2*008).

2.5.4 Maintenance Priorities

It is also very important to allocate the limited resources available for the maintenance purpose in such a way that it satisfies objectives and maintenance polices of the roads authority. The following basic approaches can be used to determine priorities for pavement maintenance:

i. **Urgent maintenance**- such as emergency repairs to pavements that are cut, removal of debris and other foreign objects.

ii. **Routine drainage maintenance**; ditch cleaning and deepening, cleaning bridges and culverts, backfilling scoured areas, constructing check dams and etc.

iii. **Routine maintenance of pavement**- such as patching, sealing and repairing of road furniture.

Periodic maintenance- such as resurfacing

As indicated above the routine drainage maintenance should get more priority than the routine maintenance on pavements as repairing pavement surface defect caused by drainage problem is wastage of resource unless the drainage is first corrected.

2.6 Urban Road Maintenance Costs and Cost Varying Factors

This section first focuses on the factors that determine initial urban project costs and then examines some of the more important determinants of cost changes over time. If left unchecked, minor maintenance problems tend to become more serious and more expensive to repair. The South African National Road Agency Ltd. (SANRAL, 2009) for example, estimates that repair costs can rise to six times maintenance costs after three years of neglect and to 18 times after five years of neglect. However, finding the

necessary funding for maintenance can be difficult. Bennett and Greenwood (2004) posit that road maintenance costs can vary significantly depending particularly on:

- The type of road, surface and construction quality;
- How much it is used, particularly by heavy vehicles,
- Organizational, logistical arrangements,
- Technology choice for each operation,
- Type and cost of works equipment and transport used,
- Local labor and materials costs, and
- The quality and timeliness of current and previous maintenance.

It is therefore important to consider the cost of maintenance when planning investment in any urban road maintenance projects, setting appropriate standards and specifications for the road and the approach to contracting and procurement. On lower category roads the involvement of the local community or stakeholders can substantially reduce the operational and overhead costs (Miles *et al.,* 2007). At the initial planning stages the 'whole life costs' of the road should be considered as an integral part of the design process - not just the short-run capital costs of the initial construction, but also the long term costs of its maintenance (McLean and Foley, 1998). What this implies is that realistic assessment of the capability and likelihood of timely road maintenance will be a major influence on the effectiveness of the construction investment.

Frequently problems arise because these road maintenance costs have either been underestimated, or insufficient financial provision has been made for them (World Bank, 2011). Takeyama and Hoque (1995) also argue that the cost of maintenance can also often be reduced by better evaluation of condition, prioritization of works, improved contracting or by the use of more innovative approaches such as labor-based

or community contracting in remote or rural areas, or by the use of performance based contracts. The authors observe that force account or direct labor approaches were often used by road authorities, particularly for routine maintenance. These approaches have been actively discouraged in recent years due to observed under-performance. However, both force account and private sector approaches have their advantages and disadvantages. Careful assessment of both of these approaches should be in the local environment. A key requirement for either method is to be able to fully cost (especially finance, overheads and equipment replacement costs on a sustainable basis) and monitor performance and take action to remedy any shortcomings.

According to Little and Mirrlees (1990), up-to-date network asset (inventory) and needs assessment (from condition surveys) can help to identify and quantify maintenance requirements, estimate works costs and together with realistic performance assessment can help to make bidding and negotiating for funding with stakeholders more successful. In addition to the guide on "Why road maintenance is important and how to get it done" the World Bank (2001) produces a number of guidelines or tools for road maintenance. This includes the Highway Design and Maintenance Standards Model (HDMSM) which incorporates the research of road deterioration in a number of regions and can be used by planners and management organizations to estimate the total transport costs of alternative road improvement and maintenance strategies through life-cycle economic evaluation. Effort and care must be taken to calibrate and adapt the model for local conditions. The World Bank (2001) has also provided a number of guidelines to different approaches to contracting, particularly performance-based contracting for road maintenance.

Options for maintenance can vary widely according to the type of road and by the type of contracting and procurement systems chosen. There has, for example, been some excellent work carried out to develop labor-based, local and community contracting but the experience has shown that this approach, whilst cost-effective, needs careful planning and usually the oversight and support from road management organizations if it is to be sustained in the long-term (Ghana Road Fund Inception Report, 1997). The labor based system has been used in various forms in many countries. However the system is dependent on a consistent provision of funds and supervisory support. If this is withdrawn for a period of time, the consequential backlog of work can overwhelm the system and necessitate expensive, large scale rehabilitation (Bekoe, 2012). Adequate monitoring of the road network is also necessary to ensure that it performs as anticipated and that maintenance is adequate - particularly where performance-based contracts have been used.

Developments are continually being made to the available technology, materials and approaches to maintenance. In recent years there has, for example, been increased interest in the use of marginal or non-standard materials, recycling and local materials in road maintenance.

Potter (1997) argues that no two infrastructure projects will cost the same amount of money no matter how similar they are. Apart from basic technical factors, the wide range of economic and institutional conditions in different countries will itself always lead to variations.

Nevertheless, Gwilliam and Zmarak (1999) assert that the fundamental project costs are based on the actual cost of the materials, equipment and labour in the region where

the project is being procured. There is general agreement among several authors (Angelides, 1999; Miles, 2007; Wildord, 2008; Aidoo, 2011; Gbadegesin, 2011; and Nyarko, 2011) on the subject of road maintenance that, the basic costs of road maintenance will vary depending upon a number of factors. Some of these factors are discussed below.

2.6. The Project Specification

According to Wildord (2008), the specification defines the physical attributes of a project. With urban roads, for example, given levels of forecast traffic will lead to specification of the required length, depth and width of the road pavement, the material to be used for surfacing, the number of lanes, bridges and junctions etc. Generally, the more detailed the specification and the larger the project, the more expensive it will be.

Location

Location affects project costing via institutional factors and through geographical realities. Institutional factors can affect initial project cost estimates in a number of ways. Consents procedures in particular may be more arduous in some countries, affecting the time it will take to successfully implement a project. Allowance for the costs involved in sustaining a long public consultation exercise is an example. Where major projects are likely to be strongly opposed on environmental grounds, more cost may have to be allowed for environmental mitigation measures (Wildord, 2008).

In geographical terms, construction and material costs, land costs and design standards vary widely across the various parts of the country because of the varying distances from suppliers, climate and weather conditions, and general market conditions. Even within a country, variations will exist depending on whether a project is being implemented in a peripheral or central area, or in an urban or rural context. Generally, the more remote a project is, the more expensive it will be because of the cost of transporting construction materials and equipment to the site. In an urban location, land costs are usually much higher.

2.6.1 Form of Procurement/Contract

World Bank (2001) also posits that the form of procurement and contract used by the project sponsor can alter the estimated cost of a project. Cost savings may be made by means of lump sum contracts although these are usually marginal in relation to the total project costs. Design, Build, Finance and Operate (DBFO) contracts, which seek to transfer most of the risk of cost over-run from project sponsor to contractor may in some circumstances yield savings. With conventionally financed road maintenance contracts, the contractor is paid we pay the contractor is paid as the works progress. Such projects are fully paid for on completion and maintenance is dealt with in separate contracts.

2.6.2 Site Characteristics

Angelides (1999) also argues that site can be affected by soil and drainage conditions and access restrictions which can affect the original cost estimates. The amount of excavation, piling and foundation activities required are particularly affected by poor

ground conditions. Where there is uncertainty about ground conditions, accurate project costing cannot be achieved unless a soil survey is undertaken.

This may require the sinking of boreholes to obtain soil samples at different levels beneath the surface.

2.6.3 New Build or Improvements

Generally, the construction of new infrastructure is more expensive than improvements to existing infrastructure, or refurbishments (Aidoo, 2011). This is primarily because the "non-building" costs such as land purchase, foundations, services provision etc. do not have to be included when simply upgrading existing structures.

2.7 Factors Which Change Costs Over time

Once implementation begins, an urban road maintenance project's costs rarely remain static. As further information becomes available the costs may be further defined. Yet, even when a cost has become firmly fixed, there are numerous factors that can lead to the cost increasing. Delays are a major factor. Whatever the reason, delays almost invariably increase budget costs. Many events may have contributed to the delay – some which could have been foreseen and others which could not. In the context of government of Ghana (GoG) road project funding, time and cost over-runs have obvious implications for the number of road maintenance projects that can be funded within a period, and for the scale of the outputs and impacts generated.

Research has found that many urban road maintenance projects experience a range of problems in both the pre-construction and implementation stages (Nyarko, 2011). These lead to projects overrunning either in time or costs. As indicated above, delays

generally translate into higher project costs. A key consideration in the context of GoG funding is the time at which an application for funding is actually made. Applications can be made at three main points in time (Agbodjah, 2010):

• Very early in the construction cycle when broad cost estimates only are available;

• On the basis of tender prices for the work to be undertaken;

• Retrospective bids where the project has been completed but grant is still required.

The level of certainty about the final or outturn costs will vary for each of these three situations. Obviously, if an application comes forward very early in the project development cycle, then there is a much greater chance that the project will experience time and cost over-runs.

2.7.1 Poor Project Management

According to Gyamfi and Guillermo (2012), the role of the project manager or project management team is probably the most important element in containing the costs of a project. It is often true that a poor project with a good project manager will be completed satisfactorily. But even a good project, if combined with poor project management, will almost always face serious difficulties.

A poor project management structure will have an impact at all stages of the construction process leading to:

• Lack of planning and coordination;

• Poor communication between members of the project team and the project sponsor;

• Failure to identify problems and institute necessary design and programming changes;

• Lack of control over time and cost inputs.

Design Changes

A change in a project's design can arise for a number of reasons. It may be that the project sponsor wants additional elements to be included in the project or changes to existing ones. Usually, these design changes require additional time inputs from architects and engineers as well as the additional time and cost inputs from the contractor and for additional materials.

Unexpected Ground Conditions

Ground conditions can be assessed by a desk-based review of relevant published documentation and through the use of trial pits and borehole sampling onsite. However, the actual site conditions for the full extent of a project are not usually determined until construction begins. It is possible that difficult condition is overlooked by the initial review or that conditions have changed due to adverse weather conditions or changes in sub-soil conditions. Unexpected sub-surface conditions can, at times, require fundamental redesign of projects at great expense. Changes in surface ground conditions can lead to problems in actually moving machinery and supplies around the site, and in undertaking excavations and laying foundations. This can also increase costs and add to the construction time required.

Cost Changing Factors

Shortages of some construction materials, construction plant (machines and equipment used during construction) and service plant (equipment used in the operation of the infrastructure project). If this was not anticipated in the original cost estimate, delays may occur and/or the prices of these elements increase.

Inappropriate Contractors

Contractors are selected on the basis of price, experience in undertaking particular types of project and their track record in producing high quality work within budget and on time. Problems may arise where there is a high level of development activity being undertaken in a particular region and the better contractors are not available to bid for the work at that time. Alternatively, the tender review process may not have been undertaken by the personnel with the best understanding of the services required. As a consequence, firms which are not the most experienced in that field of activity are chosen, often with implications for the quality and cost of a project.

Delays in project implementation and increases in costs can arise through the use of ineffective or inappropriate labour, or errors in calculating how productive the labour will be. This can happen especially when sub-contractors are used whose quality is not controlled in the main project contract. In most cases there is a trade-off between price, experience and track record but the desire to accept the lowest tender does not always lead to a project that is completed within time and budget (Wildord, 2008).

There are cases of contractors and sub-contractors who go into liquidation during the construction period. This can lead to significant delays and extra costs arising as the project sponsor has to re-tender the remaining work. Identifying a new contractor to complete another contractor's work is difficult because of the possible liabilities that the new contractor would have to accept for another company's work (Wildord, 2008).

Funding Problems

The overall lack of finance to complete a project, or delays in the payment for services by the project sponsor can lead to significant problems arising. If the costs of a project have increased significantly beyond the original estimate, then work on the project may have to stop or be delayed until additional funds can be found. Funding problems can

also arise if funds allocated to one project have been diverted to other projects within a programme of development. If the payment of invoices by a project sponsor is slow, the contractor may begin to commit fewer resources to a project, and may even cease work if cash flow becomes a problem. In some cases, even when a project is expected to be entirely profitable, project sponsors may understate the availability of local funding simply in order to maximize the level of grant. This can happen with revenue-generating projects particularly. Such practices can reduce the availability of funding for other projects (Wildord, 2008).

2.8 Road Maintenance Cost Mitigation

The purpose of this section is to review ways in which the cost management of urban road maintenance projects can be improved by risk management and by more realistic estimation of contingency budgets. Whilst this is ultimately the responsibility of project sponsors and their project managers, an understanding of the principals involved should also be of value to all stakeholders in urban road maintenance.

Routine maintenance is a recurrent activity (Parker, 1998). Therefore, careful timing of work inputs forms an important part of an efficient maintenance program. The prime objective when scheduling maintenance works is to ensure that the works are carried out as preventive measures, at an early stage when the road deterioration and damage are still limited. The works are therefore scheduled at strategic intervals when it is expected that the need for action is essential. For this reason, the timing of regular, or routine maintenance works are often related to the time of the year when rainfalls occur.

All road works are planned and implemented as projects (ATC, 2006). A project is a temporary endeavor with a defined beginning and end (usually time-constrained, and often constrained by funding or deliverables), undertaken to meet unique goals and objectives, typically to bring about beneficial change or added value (Gido and Clements, 2006). The temporary nature of projects stands in contrast with business as usual (or operations), which are repetitive, permanent, or semi-permanent functional activities to produce products or services. In practice, the management of these two systems is often quite different, and as such requires the development of distinct technical skills and management strategies. The primary challenge of managing road maintenance projects (like any other projects) is to achieve all of the project goals (Ireland, 2008) and objectives while keeping in mind the preconceived constraints. The primary constraints are scope, time, quality and cost (PMI, 2010) The secondary —and more ambitious— challenge is to optimize the allocation of necessary inputs and integrate them to meet pre-defined objectives.

This means that all agencies involved in road maintenance projects need to factor in budgetary limitations when planning their maintenance project. Every engineer responsible for road maintenance faces the additional challenge that available funds are never sufficient. It is therefore necessary to assess the importance of the various work interventions to ensure that available resources are utilized in the most effective manner.

Among the three types of maintenance, obviously the emergency maintenance is the most important as it relates directly to keeping the roads open to traffic. In terms of non-emergency related works, experience clearly shows that it is the regular or routine maintenance activities related to preserving the drainage system which have the most

significant effect in terms of extending the lifetime of a road. These works do not involve any sophisticated technology or skills. They can be carried out using manual labor and simple hand tools and are inexpensive. Despite this, they still require sound project management techniques to ensure that works are carried out at the right place and time (Abaza and Ashur, 1999).

2.8.1 Uncertainty in Project Costing

The preparation of project cost estimates is a difficult task because road maintenance projects are subject to risks and uncertainties, particularly in the early stages when very limited information about the project is available (Kumar, 2010). Yet, the cost estimates prepared at this stage are most important to the project sponsor because they often form the basis of the bid for funds. As a project progresses, more information becomes available to allow costs to be calculated to a greater degree of accuracy, for example the ground conditions on-site or the specific types of plant or machinery that will be provided. More reliable cost estimates become available after tenders have been received from contractors.

Nevertheless, many aspects remain uncertain and normal costing practice is to include an extra element to provide "insurance" against cost over-runs (Drurry, 2008). The word "contingency" is usually used to describe this additional cost element. The contingency, according to Gido and Clements (2006) is typically based on a "rule of thumb" calculation, as a certain percentage of the base cost estimate or a lump sum based on the experience of the estimator. A figure of 10% of gross costs is a common allowance. This risk allowance or contingency sum is often calculated only once and is not reviewed again as the project progresses.

The main weakness of this simple approach to contingency costing is that individual risks are not separately evaluated. As a result, a contingency is often set too high for low risk projects, or too low for high risk projects. In addition, it is not always appropriate to carry a specific contingency allowance for the duration of a project since many of the risks become known and can then be eliminated.

2.8.2 Risk and Contingency planning

By giving greater attention to which cost determining factors are most likely to change, and why, project sponsors should be able to develop more accurate contingency estimates (PMI, 2010). This in turn should reduce the risk of cost over-runs. Poorly managed risk affects the ability of a project to be completed within time and on budget. On the other hand, the level of risk can often be reduced if project sponsors take the time to identify, assess and manage the main factors leading to cost escalation. Although a potentially complex subject, risk management basically involves three quite simple stages (Hilson, 2006):

• Risk identification: what could go wrong?

• Risk assessment: it is possible to quantify or at least rank any of the risks?

• Risk management: what steps can be taken to mitigate or manage these risks in order to prevent cost over-runs?

Once the risks have been identified and assessed, they must be continuously monitored until the end of the project. Although careful risk assessment typically results in an increase in initial cost estimate, it usually leads to a reduction in contingency. Risk management measures are worthwhile because they lead to a more certain final project

cost. Often it is not clear what is actually contained within a project's contingency budget. As noted above, it could just be a general percentage estimate. In careful risk management the contingency allowance for larger projects should cover three main types of contingency (PMI, 2010):

• Special risks contingency – an allowance to cover the risks arising from higher land acquisition costs, changes in external factors such as the availability of funds, statutory requirements and force majeure.

It can also cover the risk of a project sponsor changing his mind about the project specification.

• Design contingency – an allowance for use during the technical design process to provide for the risks of changes due to design development or in estimating data.

• Construction contingency – an allowance for use during the construction process to provide for the risk of changes due to site conditions or as a result of changed construction methods or poor performance by contractors or sub-contractors.

The use of a better specified contingency will only be effective if suitable project control procedures are in place to control all aspects of project performance.

Project control procedures should be organized and managed by the project manager. They should provide essential, coherent management information so that the project sponsor and project manager can react to changing circumstances. Finally, improved contingency planning can never be a substitute for good project management. The essential elements of good project management are:

• Cost control: managing the design and construction processes to achieve best value for money and ensuring that the final cost does not exceed the budget.

• Time control: managing the design and construction processes so that the project is completed on or before the agreed completion date.

• Quality control: ensuring that the quality and performance of the completed project meets the project sponsor's original objectives.

• Change control: ensuring that any changes that are necessary are achieved within the approved budget, that they represent good value for money and that authorization to proceed has been obtained from the project sponsor.

2.9 Road Maintenance Management Experience from the local perspective

The World Bank through its studies has found out that each country needs a road maintenance management system that is unique to its conditions. This is so because the roads sector policies are different in each country (Hoban, 2004). The maintenance approaches, procurement and management methods are also different in each country. The experiences from Ghana, Ethiopia and Tanzania in road maintenance management are discussed below.

Ghana

Road works in Ghana is managed by the Ministry of Roads and Transport through the Ghana Highway Authority (GHA) which has transformed road maintenance over the years from a predominantly force account (in house) approach to at least 90% execution of works by contracting. A Road Maintenance Project financed both by GHA and Gesellschaft für Technische Zusammenarbeit (GTZ) is currently developing a computerised Road Maintenance Management System (RMS) which seeks to provide tools for effectively and efficiently managing road maintenance in Ghana. This system is expected to cover planning, budgeting and work execution components. Under

planning and budgeting component, road inventory, road condition survey and data storage system will be covered; under work execution component, maintenance activities, performance standards and work supervision will be considered (GHA, 2007).

This system is expected to increase efficiency by reducing the paperwork and time required to manage road maintenance works by Ghana Highways Authority. This system is being customised to Ghana road sector policies.

2.9.1 Summary of Literature Review

The literature reviewed can be summarised as:

- Countries are now moving from the traditional manual methods of managing road maintenance to modern methods such as the use of technology to improve efficiency.
- There have been several changes in the road maintenance approaches from force account to utilisation of private contractors which presents management challenges.
- In the past, there have been attempts to develop road maintenance management systems but there has been no successful attempt.
- There are several challenges being experienced from the current road maintenance management practise such as, inefficiency of the maintenance management system, openness to corruption and maintenance operations not being practised in a standard way in all the districts.

From the review above, it is obvious that literature is replete with several strategies that can be adopted by roads and highways regulators to expensive large scale maintenance (Bennett and Greenwood, 2004; Ghana Road Fund, 1997; SANRAL, 2009). Yet, urban roads maintenance projects in Ghana have been given little attention in literature and it is unclear what kind road maintenance interventions have been adopted by the urban roads department over years. This present study therefore identifies effects of irregular maintenance roads on life cycle project costs and seeks to examine evidence on initiatives to maintain urban roads, especially in urban areas and also suggest ways to address the increasing road project costs.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

Chapter two has provided extensive body of literature that expounds on the urban road maintenance situation in Ghana, types of road maintenance. Some key definitions, principles and concepts were explored. This chapter provides detail on the methodology used to conduct the research. This includes a description of the research population and sampling techniques, the instruments used to collect relevant data and the specific tools and techniques used for data analysis.

3.1 Research Design

The study adopts the survey research design. According to Sproul (1988) research design can be used to categories into experimental design and non-experimental design. The study is carried out by gathering data from primary sources in order to achieve the

research objectives**.** Research strategy was chosen purposefully based on the elements of assessment in this study.

Under this strategy, the research methods adopted were field survey and qualitative interviews. Survey was conducted through the review of 'road plan' documents on some urban roads and specific documents on road management within the Accra Metropolitan Area, collected from the Department of Urban Roads. Also reviewed for secondary data were the 2008 – 2012 national budgets of Ghana. The review of the national budgets was aimed at finding the annual allocations made to the sector, road maintenance project costs and the respective revenue contribution from the sector to the country's economy annually. Road Maintenance Engineers, Maintenance Supervisors, Metro Road Engineers, Quantity Surveyors, Budget Officers and Project Planners were interviewed.

3.2 Target Population

With the specific focus of this study, the targeted population included all Urban Roads Management experts at the Urban Roads Department in Accra specifically Okaikoi – North, for area A, Okaikoi –South for area B, East Ayawa-so for area C and Osu-krotey for area D. Namely: Road Maintenance Engineers, Maintenance Supervisors, Metro Road Engineers, Quantity Surveyors, Budget Officers and Project Planners in the Accra metropolis. Twenty three (23) management experts formed the sample size of the population of the studies. According to the Urban Roads Department of the Accra Metropolis there are 23 engineers in the selected areas.

3.3 Sampling (Methods and Techniques)

The sampling method employed in the study was purposive sampling technique. The potential were Road Maintenance Engineers, Maintenance Supervisors, Metro Road Engineers, Quantity Surveyors, Budget Officers and Project Planners in the Accra metropolis. Semi structured questions were prepared to elicit data from the participants.

3.4 Data Collection Instrument (interview)

3.4.1 Interview

Structured semi-questions were used for the interview. The interview structured formats lead to four sections. Section A- deals with personal data of participants. Section B- was aimed at soliciting information on maintenance plan of Department of Urban Roads (DUR)

Section C-was to solicit data on Department of Urban Roads (DUR) maintenance budget.

Lastly section D- meant to find out the actual yearly maintenance cost of Department of Urban Roads (DUR)

3.5 Observation

A survey was conducted in Accra Metropolitan to ascertain the state of roads in the metropolis.

3.6 Data Analysis

In analyzing the data collected, both the descriptive and quantitative methods was used. Simple logical discussions, analysis and interpretations based on the data were presented in relation to the study objectives.

Pie and bar charts will be used to present and analyze data collected from the field .The data will be computed into percentages and subsequently presented in the form of pie charts, bar charts and tables.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

4.0 Introduction

This chapter presents results obtained in relation to the objectives of the study in the previous. The primary data presented in this section was obtained through interview of the staff of Department of Urban Roads. The data was analyzed to assess the road maintenance situation in Accra with particular focus on cost mitigation strategies for efficiency in road maintenance projects.

4.1.1 The Personal Data of Participants

Figure 4.1. shows that 65.8% of participant have worked more than ten (10) years in the organization, Twenty Three point seven percent (23.7%) also confirmed they had worked with the Department of Urban Roads between five to ten (5-10) years, whiles the remaining four 10.5% responded that they have worked with their organization

between one to five (1-5) years. The majority of the respondents have stayed long enough to give relevant information on the organization's role in urban road maintenance.

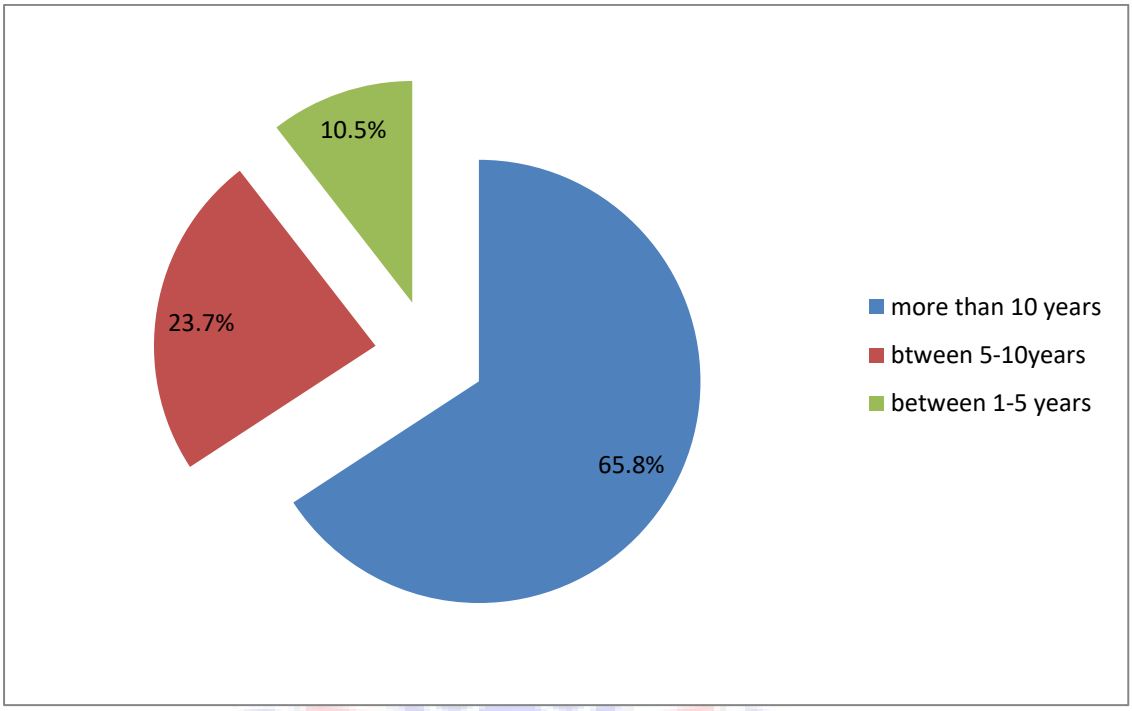

Figure 4.1 Number of Years Spent with DUR (Working Experience)

Source: Field Data (2016)

4.2 Background Data of Participant

4.2.1 Profession of participant

The study result hold that majority 52.1% of the participants were maintenance supervisors (30.4% were holding Bachelor's degree civil engineering and 21.7% were also holding HND in civil engineering), 17.9% of the respondents were road maintenance engineers (all the road maintenance engineers had Bachelor's degree in civil engineering), 13% were quantity surveyors (all the quantity surveyors had Bachelor's degree in civil engineering), 8.7% were project planners (all the project planners had Bachelor's degree in Planning) whiles 4.3% was metro road engineer

holding Master's degree in Civil engineering and 4.3% was budget officer holding Bsc in Land economics.

Table 4.1. Record of participant

Participants	**Area number**				
	Area A	Area B.	Area C	Area D	Total
Road maintenance engineer	1	1	1	1	4
Road supervisor	2	3	4	3	12
Budget officer	1	-	-	-	1
Project Planners	1	-	-	1	2
Metro Road Engineers	1	-	-	-	1
Quantity Surveyors,	1	1	-	1	3
Total	**7**	**5**	**5**	**6**	**23**

Source: Field survey, (2016).

The areas are:

Okaikoi –North, for area A, Okaikoi –South for area B, East Ayawa-so for area C and Osu-krotey.for area D.

4.3 State of Roads in Accra Metropolis

From the interview and data from DUR, as indicated in Table 4.2 there is 775km of paved road represent 54% of the roads in the Accra metropolis. A road length of 658.37km represent 46% is unpaved. In all there is a total of 1433.37km of network in the Accra Metropolis. The urban road network in the country is estimated to be 4062km of which 1935km is paved with 2128.85 is unpaved. It could be deduced that less than half of the urban roads network in Ghana is paved.

Table 4:2 Condition of Road

	Paved		Unpaved		Total
	Figure	%	Fig	%	
Accra	775km	54	658.37km	46	1433.37km
Country	1935.10	47.6	2128.85km	52.4	4062km

Department of Urban Road

4.3.1 Nature of Road Surface

Through personal observation at the sub- metro area with the Metro road engineer. In area A, who also doubles as metro engineer in areas B, C and D.

About 45% of roads are in poor condition, some have are deep potholes on the roads that are potential hazard to vehicles and pedestrian, 27% are in fair condition means the potholes are not too deep making cars to apply on them with minor swerving and 28% is in good condition means no apparent defect.

Table 4.3 Nature of Road Surface

	Good	Fair	Poor
Accra	28%	27%	45%

Source: Field Record, (2016)

4.4. Urban Road Maintenance Plan

When asked the maintenance plan usually adopted by Department of Urban (DUR). All participants namely: The metro engineer, road engineers, physical planters and supervisors from 4 sub metro offices, affirmed that the department uses periodic

maintenance culture. This is to ensure that the road does not get to an unmotorable state before going to effect remedy. Periodic maintenance has an advantage of improvement of efficiency. The majority of the participants agreed that regular site inspections are conducted in order to improve road maintenance effort.

When asked the objectives of the maintenance plan. They indicated that, the prime objective is to ensure that the works are carried out as preventive measures, at an early stage when the road deterioration and damage are still limited. The works are therefore scheduled at strategic intervals when it is expected that the need for action is essential. The researcher also asked participants how they organise periodic road maintenance. The results indicated that they organise periodic road maintenance by ensuring that well-defined system of rules, standard operating procedures and norms are in line with quality road networks every week. The results mean that periodic road maintenance is important to ensuring that all standards are met in quality road networks construction. The timing of regular, or routine maintenance works are often related to the time of the year when rainfalls occur (Parker, 1998).

No matter what technical designs are chosen, all roads, from major highways to local gravel roads, require regular and timely maintenance in order to secure a reasonable lifetime on the construction investment. Attempts to find technical designs which are maintenance-free are disillusions and in the long run only prove that lack of maintenance leads to accelerated rates of deterioration (Potter, 1997).

From my filed observation, almost half of the roads visited are in a poor state, so I went further to ask if periodic maintenance is adopted, why it is that almost 50% of the tired road a in poor condition.

The planner and the budget office reacted this way. ‘’we always budget for the anticipated distances that are due for maintenance, but in most case the money received are not adequate enough to effect maintenance of the projected roads’’. These sometimes delay the maintenance timelines by three years.

4.5 Urban Roads Life Cycle Cost

4.5.1Measures to ensure economic life cycle cost of the projects

Participants were given the opportunity to express their opinion on methods to ensure east effective road maintenance techniques that would ensure economic life cycle cost. To facilitate easy analysis, they were given some options to select from. The options were selected based on previous studies by Heggie (2004).

Table 4.4: Which measures to ensure economic life cycle cost?

Factors to ensure economic life cycle of road	Frequency	rcentages %
Work supervision during construction	3	13.1
Quality control	5	21.7
Work completion on schedule	5	21.7
Site inspection of completed road	9	39.1
Good workmanship	1	4.4
Total	**23**	**100**

With respects to the interview of the processes used in cost effective road maintain. The data as shown on Table 4.5 indicates that majority 39% of participants indicated regular site inspection of road to identify spot signaling failure and effect sport improvement. Also 21.7% said that quality controls work completion on schedule can enhance road

life cycle cost whiles 13% mentioned that frequent work supervision improves during construction can enhanced life cycle cost of the road. Good workmanship was cited the least.

4.5.2 Response to Emergency Maintenance Work by DUR

Research has revealed that quick response to failure extend the life span of project

A question was asked to find out from the participant if, apart from periodic and scheduled maintenance, there were cases of emergency road maintenance. The summary of the response is shown on the pie chart in Figure 4.2. it from the results 12 participant all from Okaikoi North and Ayarwa-so confirmed that there was no immediate response from the maintenance unit engineer with regards to emergency maintenance needs, they wait until they are budgeted for, while the participants from Okaikoi South. and Osu Klutey sub metro mentioned that, emergency maintenance works were carried out when they developed major problems and the situation is critical. These two sub metro, according to the budget officers, they make provision for emergency in their annual budge. They were further asked whether timely intervention is carried out when road defect is detected. All the participants said, they only carryout maintenance when not complete.

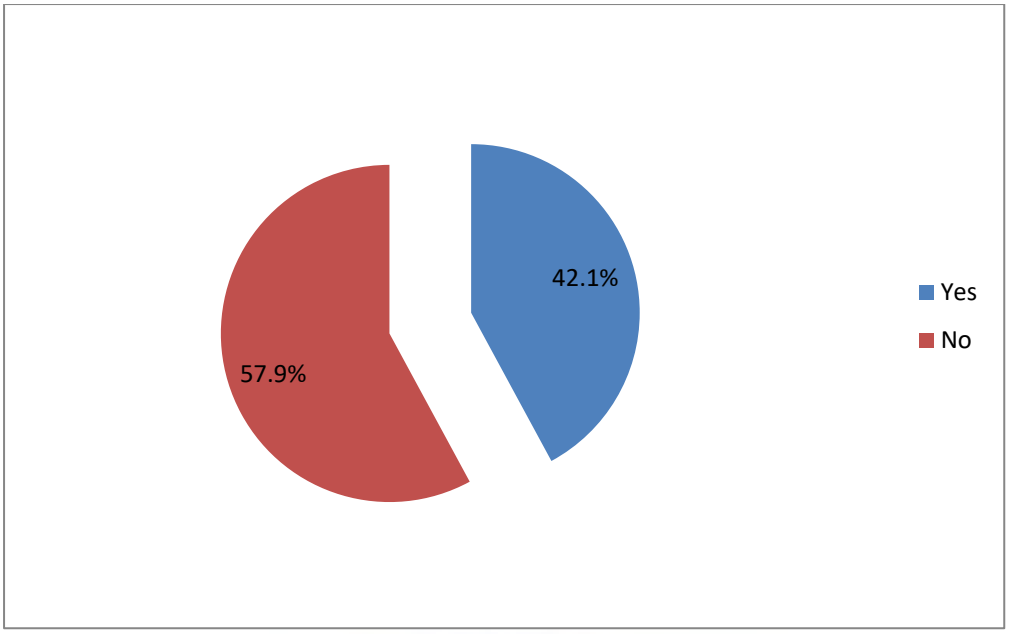

Figure 4.2. Emergency Maintenance Work

Source: Field Data (2016)

4.6 Funding of Urban Road Maintenance Budget

The study sought to establish how urban road maintenance projects are funded. The results obtained are summarized in Figure 4.3

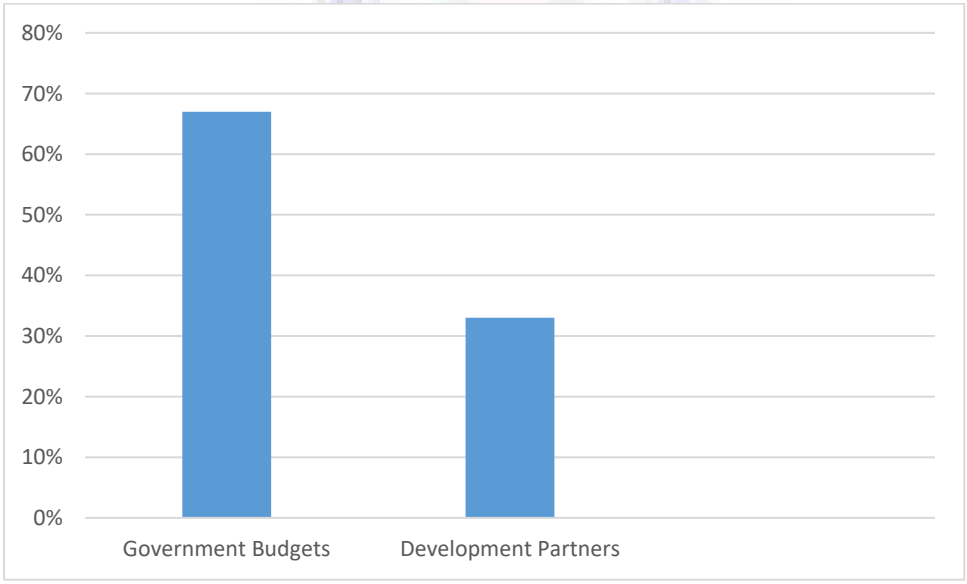

Figure 4.3 Funding Urban Road Maintenance Projects

Source: Field Data (2016)

Figure 4.3 illustrates that majority of participants, agreed that participant government of Ghana major source of funding for urban road maintenance whiles minority 33% are funded by development partners.

4.6.1 Annual Costs of Urban Road Maintenance

From the Table 4.7 the thematic years under review 2014, a total government budget for urban road maintenance was GHC 885, 829.33, of which 33% was released. In the year of 2016 as by the end of the second quarter, a total road budget of GHC 353,092.39 was allocated to the urban road maintenance out of the total budget only 30% was released. The remaining 70% was not released. In the year of 2016 a total government budget of GHC 377229.51, 28% was released but the remaining 72% was not released. It could be deduced that from the past three years, about a third of the estimated cost of maintenance budget is released, leaving 70% not released. The Table 4.5 indicates that in most cases of the department of urban roads face budgetary constraints that hamper road maintenance. The year 2015 recorded the second highest release of funds and thirdly, 2016 recorded the lowest percentage of funds release for maintenance works. According to the road engineer and the budget officer, sometimes based on expectation and the urgency of the work, contracts are awarded, hoping to receive funding from the Government of Ghana (GOG). In most cases the funding are not forth coming or it delays. This in most cases end in the abandonment of work by the contractors. The overall lack of finance to complete a project, or delays in the payment for services by the project sponsor. For examples if the costs of a project have increased significantly beyond the original estimate, then work on the project may have to stop or be delayed until additional funds can be found. Hence a lot of maintenance work in the cities are either not fully completed or completed not on schedule.

Table 4.5: Annual Costs of Urban Road Maintenance

Year	Budget	Amount released (%)	Amount not released (%)	Funding gap GHC
2014	885,829.33	33%	67%	593,505.65
2015	353092.39	30%	70%	247,164.67
2016	377279.51	28%	72%	271641.24

Source: Field Data (2016)

Thus is a reflection of section 4.2.1, where the departments, although adopting periodic maintenance, still have about 50% of the road poorly maintained, due to low released of funding from the main sponsor, the Government of Ghana.

Conclusions

The study deduced that less than half of the urban roads network in Ghana is paved. Furthermore, funds to maintain roads are rarely released. This affected regular maintenance work on the urban roads. Moreover, frequent supervision reduced road maintenance work and improved road safety management on the urban roads.

CHAPTER FIVE

SUMMARY OF FINDINGS RECOMMENDATIONS AND CONCLUSION

5.0 Introduction

The purpose of this study was to improve key stakeholders' understanding of the effects of irregular road maintenance on urban road project costs. This is so that they will be in a better position to interrogate those projects where there is reason for concern over initial project costs, or changes in these costs. This final chapter sets out the conclusions drawn from the results already covered in the previous chapters. The concluding part of the chapter provides the way forward by way of suggestions and recommendations.

5.1 Summary of Findings

The purpose of this study was to improve key stakeholders' understanding of the effects of irregular road maintenance on urban road project costs. The study adopted the survey research design. Quantitative research method was used to gather primary data. The population for the study was 23 consisting of Urban Roads Management experts at the Urban Roads Department in Accra specifically Okaikoi –North, Okaikoi –South, East Ayawaso and Osu-krotey. The researcher used purposive sampling technique to select 23 respondents for the study. Interview guide, questionnaires and observations were used to gather primary data. In analyzing the data collected, both the descriptive and quantitative methods were used. Tables, frequencies, percentages, Pie and bar charts were used to present and analyze data collected from the field. The key findings of the study were highlighted below;

Majority of participants perceive road maintenance as consisting of timely repair of roads as well as preventing deterioration. The practice of maintenance is mentioned as a major mode of ensuring the sustainability of this road. Generally, the study results indicate lack of comprehensive road maintenance programs. As such periodic maintenance is clearly absent in the practice of urban road maintenance. With apparent lack of periodic maintenance programs, the lifespan of urban roads cannot be prolonged or even ascertained.

Lack of adequate funding and poor project planning has been identified as the main causes of irregular, non-periodic maintenance with the Urban Roads Department. Emergency road maintenance works were not attended to in a timely and efficient manner due to delays in securing funding for such projects.

This calls for attention to innovative funding strategies such as the development of public-private partnerships and the need to increase funding commitment to urban road maintenance. A key finding of the study was that majority of participant surveyed confirmed irregular urban road maintenance has adverse effects on roads. Some of these adverse effects, according to participants include unsafe roads, reduction in vehicle performance, increased road user costs and worsened condition of roads than they were originally designed.

It was also evident from the study that majority of those consulted in the course of the study opined that major urban roads in Accra were in a deplorable state. Although site characteristics and location can increase maintenance costs considerably, the timescale

and form of procurement contract have been well noted among participants as the major cost drivers.

5.2 Conclusions

In all, it is justifiable to conclude that the Government of Ghana rarely released funds to renovate or maintain urban roads in the Greater Region. This prolonged the time when a major input of funds is required to solve the problem caused by the lack of routine maintenance. The social and economic impacts of urban roads are well established including improvement in urban access, which facilitates marketing, schooling and health services. Better access provides the opportunity for increased income and employment opportunities and also contributed to the alleviation of poverty. Unfortunately, maintenance of urban roads is seriously neglected in Ghana. Areas with poor road access are generally more disadvantaged than areas which are better served. Investments in rural roads can therefore often be justified from both a socio-economic and a poverty reduction point of view. Nevertheless whatever benefits they provide are short lived if they are not maintained.

5.3 Recommendations

According to the summary and conclusion remarks highlighted above, the study recommended that;

1. The government and development partners should invest in routine road maintenance activities to sustain the Accra Metropolis road network. This is because according to the results of the study funding road maintenance projects are not frequent and this affects the sustainability of the road network.

2. There Ministry of Roads and highways should conduct periodic road maintenance seminars, forums and workshops to enhance the expertise of the road maintenance engineers.
3. The Government of Ghana through the Ministry of Roads and highways should periodically release funds budgeted for the year to the sector to improve and implement road maintenance programmes.
4. To be able to even begin to plan road maintenance, engineers and technicians need to have an understanding of the road network. This implies that key data on the length, traffic levels and condition of the roads is known with some degree of confidence. Without this it is simply not possible for engineers to develop and effectively raise argument for providing funds for the roads.
5. The road maintenance engineers must show that they have identified the key links in the road network, understood what is required to maintain them and provide a coherent budget and plans to implement the work.

5.4 Suggestions for Further Research

Based on the recommendations of the study, the researcher suggested that a similar study should be conducted to investigate the impact of training and development on road maintenance engineers productivity using the Accra Metropolis as a case study.

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APPENDIX A

UNIVERSITY OF EDUCATION WINNEBA -KUMASI CAMPUS

Dear Participant,

The researcher is a post graduate student at the University of Education, Winneba, Kumasi campus conducting a piece of research to investigate the **EFFECT OF IRREGULAR ROAD MAINTENANCE ON THE LIFE PROJECT CYCLE COST (CASE STUDY OF GOVERNMENT URBAN ROAD IN ACCRA MUNICIPALITY)**. This questionnaire is to enable the researcher to collect necessary information to complete the dissertation. Kindly provide answers to the following questions below. All information provided in this study will be treated as confidential and your anonymity is assured.

Name of Organization…….

Department…….....

Personal Data

Please write or tick ☑ the appropriate response to each question.

1. Sex: Male [ ] Female [ ]

2. How long have you worked with Urban Roads?

a) 1 year -3 years [ ] b) 4-6 years [ ] c) 7-10 years [ ] d) Above 10 years [ ]

Descriptive Data

1. What is your general understanding of urban roads maintenance?

   a. Timely Repairs of Roads [ ] b. Preventing Deterioration [ ] c. Involves both activities [ ] d. Not Sure

2. What is the responsibility of the Urban Roads Department under the transportation ministry?

   ……

   ……

   ……

3. Can you cite one example of a major maintenance project that you are currently engaged in?

   ……

   …….

4. How often does your organization carry out road maintenance works within Accra Metropolis? a. Once a year b. routinely c. Once in every two years d. Other please specify…….

5. What prevents regular maintenance of urban roads?

   a. Inadequate Funding [ ] b. Poor project planning [ ]

   Other (please specify ……..

6. Do you observe any adverse effects of non-regular maintenance on urban roads in Accra? Yes [ ] No [ ]

7. If yes, please specify……

   ……

   ……

8. What is your general assessment of the state of urban roads in Accra?

   a. Good [ ] b. Satisfactory [ ] c. Bad [ ] c. Deplorable [ ]

9. Are there planned road maintenance budgets for emergency cases?

   Yes [ ] No []

10. What is/are source(s) of funds for urban road maintenance projects? a. Government budgets [ ] b. Development Partners [ ] c. Public-Private-Partnerships [ ] d. Other……
11. Funds for main are most often received on time.

    a. Strongly Agree [ ] b. Agree [ ] c. Strongly Disagree [ ] d. Disagree [ ]
12. Is/are the source(s) of funds sustainable and reliable

    a. Yes [ ] b. No [ ]
13. What is the yearly cost of maintenance as a proportion of construction cost for a major paved road?

    a. 2-3% [ ] b. 5-6% [ ] c.10% [ ] d. More than 10% [ ]
14. Considering the current economic environment, there has been more than proportionate increase in urban road maintenance costs.

    a. Strongly Agree [ ] b. Agree [ ] c. Strongly Disagree [ ] d. Disagree [ ]
15. In your opinion which of the following factors will most likely increase the costs of urban road maintenance?

    a. Project specification [ ]
    b. Location [ ]
    c. Form of procurement contract [ ]
    d. Site characteristics
    e. Timescale

16. Please suggest ways of mitigating high urban road maintenance costs

…….....……

……

Thank you for your time and attention.