KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

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COLLEGE OF ARCHITECTURE AND PLANNING

DEPARTMENT OF BUILDING TECHNOLOGY

USE OF PERFORMANCE BASED CONTRACTING FOR ROAD MAINTENANCE WORKS IN GHANA

A dissertation submitted to the Department Building Technology of the Kwame Nkrumah University of Science and Technology in partial fulfillment of the requirements for the degree of Masters of Science in Procurement Management

BY

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DECLARATION

I hereby declare that this submission is my own work toward the attainment of Master of Science in Procurement Management, and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

I dedicate this research work to the God Almighty through whose grace has guided me all along. Secondly, to my beloved wife, Zaynab and sons, Muntansir and Zakir, and to all the people whose love and support made this dissertation possible.

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ABSTRACT

Road authorities always strive to reduce the maintenance costs of the road infrastructure system by using various traditional methods of contracting. Due to the emerging problems faced by road agencies in controlling the quality of maintenance works and the management of time and cost related to various traditional methods of contracting, some road agencies worldwide have started to consider alternative solution to the problem.

In the light of the above, this research aimed at identifying the expected benefits and challenges of implementing a Performance Based Contracting for Road Maintenance works in Ghana. The specific objectives were therefore to identify the expected benefits, implementation challenges and routine maintenance activities that are capable of being implemented easily using Performance Based Contracting.

Samples of road maintenance administrators within the urban road network who are directly involved in the procurement of maintenance works, were surveyed using structured questionnaires. The factors identified were ranked by respondents and the data was analysed using one sample t-test, relative importance index and One-way Anova. The analysis identified cost savings, improved control and enforcement of quality standards and enhancement of expenditure certainty as the most significant benefits of using Performance Based Contracting. Allocation of risk to the party that is able to manage them, Fear of losing job, and the design of incentive payment schemes were found to be the most significant challenges with regards to the implementation of the Performance Based Contracting method. Finally, cleaning of drainage structures/kerbs, desilting works, green area maintenance and potholes patching were identified to be the routine maintenance activities that can easily be implemented using Performance Based Contracting. As noted throughout the study, the implementation of PBC on many road maintenance projects has yielded the desired results leading to some extent as high as

40% cost savings. Cost savings, enhancement of quality standards, expenditure certainty and other significant benefits identified are potential benefits that the road agencies and the country as a whole stand to gain if PBC is implemented. The prospects of implementing PBC are therefore very high for road agencies and the country as a whole and far outweigh the surmountable implementation challenges. This research is therefore recommending that legal and regulatory frame work by way of standard bidding documents be put in place so that routine maintenance activities will be awarded using this contracting method as a piloting process. Steps should also be put in place to enable staff of the various road agencies to acquire new skills for the successful implementation of this contracting method.

Key words: Performance-Based Contracting, Road Maintenance works, Routine maintenance, Benefits and Challenges.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

A good road network gives people the gift of flexible mobility. It is a source of wealth for society and for men. Roads are also a source of well being, bringing people together from a small village to a larger city (IRF, 2007).

Maintaining these roads to always ensure they perform to the satisfaction of road users is critical. The methods of delivering these road maintenances have however being evolved progressively. Historically, road agencies have moved from using in-house force account to traditional method-based maintenance contracting (World Bank, 2005).

Traditionally, contracting for road maintenance is based on the amount of work being measured and paid for on agreed rates for different work items. This method also known as the Method-based (input based) contracts where the road agency as a client normally specifies techniques, technologies and estimated quantities of work, together with the time period during which the maintenance works should be executed. The payment to the contractor is based on the amount of inputs (e.g., cubic meters of asphalt concrete, number of working hours), (US DOE, 1998).

Many countries are now heading towards Performance–Based Contract (PBC) an approach that has been deployed rapidly in the road sector for the past decades (World Bank, 2005).

Performance Based Contracting (PBC) as defined by OFPP (1994) is essentially structuring all aspects of an acquisition around the purpose of the work desired as opposed to either the manner by which the work is to be performed or broad and

imprecise statement of work. Critical elements of effective PBC are a well defined and clearly written statement of work with achievable performance standards, a performance requirements summary which sets the Performance standard for each measurable service of the contract, defines where possible, acceptable quality levels, methods of surveillance and percentage of the contract price each service represents to establish the basis of payment for acceptable and non acceptable performance and a quality assurance surveillance plan (US DOE, 1998).

1.2 PROBLEM STATEMENT

Road authorities always strive to reduce the maintenance costs of the road infrastructure system by using various traditional methods of contracting. Due to the emerging problems faced by road agencies in controlling the quality of maintenance works and the management of time and cost related to various traditional methods of contracting, some road agencies worldwide have started to consider alternative solution to the problem (Sultana *et al*., 2012).

The mission statement of the urban road agency in Ghana is to provide a cost-effective and sustainable integrated urban road transport system to ensure accessibility, safety and reliability for national development (DUR, 2014). The challenge of maintaining the roadway infrastructure at the best possible condition by investing the minimum amount of money will always keep transportation agencies searching for innovative approaches that will provide the most of benefits to taxpayers (Pinero, 2003).

In the early 1990s, some experts and engineers started to introduce an efficient method called performance-based maintenance contracting (PBC). If implemented successfully, it has the potential of reducing maintenance costs by 10% to 50%. The use of PBC also reduces agency risk and agency administrative burden. PBC has a successful record in

minimizing infrastructure maintenance costs in many developed and developing countries over the last two decades (Sultana *et al.*, 2012).

1.3 THE NEED FOR THE STUDY

Weighing concerns expressed by the general public about the poor nature of the road network against budgetary constraints and with the problems of efficiency with the traditional method-based contract arrangements, there is the need to find alternative contracting approach for road maintenance projects. In comparison to the traditional contract arrangement, Performance Based Contracting scheme allocates higher risk to the contractor, but at the same time opens up opportunities to reduce the cost of achieving the specified standards as a result of implementing new technologies, materials, processes and innovative management strategies (Zietlow, 2001).

However, while PBC offers a number of benefits for road agencies and road users, it is relatively a new approach and has not been introduced and implemented effectively by the road agencies in Ghana (World Bank, 2005). This research is therefore challenged to identify the expected benefits and challenges of implementing a Performance Based Contracting approach that can effectively and efficiently manage the road maintenance contracts in Ghana.

1.4 OBJECTIVES OF THE STUDY

1.4.1 Overall Objective

The overall objective of this research was to identify the expected benefits and the challenges of using Performance Based Contracting for Road Maintenance works in Ghana and the identification of routine maintenance activities that can easily be implemented using this contracting method.

1.4.2 Specific Objectives

The study was specifically set out to:

i. Identify the benefits of using PBC approach.

ii. Identify the implementation challenges of PBC approach.

iii. Identify routine maintenance activities that can easily be implemented using Performance Based Contracting approach.

1.4.3 Research Questions

i. What are the benefits of using the PBC approach?

ii. What are the implementation challenges of PBC?

iii. Which routine maintenance activities can easily be implemented using PBC?

1.5 RESEARCH METHODOLOGY

This research adopted a descriptive research, a Quantitative approach with the survey style that employed the use of structured questionnaires to collect data.

The researcher in the process:

i) Reviewed available literature on Performance Based Contracting.

ii) Designed and administered closed ended structured questionnaires for primary data from road administrators within the urban road network in Ghana who are responsible for the day to day procurement and the implementation of maintenance related projects.

iii) The data collected was then analysed by using descriptive statistics, relative importance index and one-way anova to identify the significant benefits, implementation

challenges and finally the routine maintenance activities that can easily be implemented using the PBC approach

iv) Findings were summarized for an informed conclusion.

v) Following the summary of findings and conclusions, recommendations were made.

1.6 SCOPE OF THE RESEARCH

This research was limited to routine maintenance activities normally undertaken by the ten (10) administrative regional offices of the Department of urban roads in Ghana. This research was also limited to procurement practitioners within the ten regional offices of the Department of urban roads.

1.7 DISSERTATION OUTLINE

- **Chapter 1: Introduction**. This chapter provides an overview of Performance Based Contracting as well as the proposed research.
- **Chapter 2: Literature Review.** This chapter reviews available literature on world wide experience of Performance Based Contracting approach, highlights the stages involved, the benefits, the implementation challenges and various routine maintenance activities.
- **Chapter 3: Research Methodology.** This chapter discusses the various methods that were employed to meet the set research objectives.
- **Chapter 4: Data Analysis and Discussion of Results.** This chapter deals with the analysis of the data collected
- Chapter 5: Summary of Findings, Conclusion and Recommendations. This chapter summarises the findings, main conclusion, the recommendations and the directions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The objective of this chapter is to review the available literature on worldwide experience of PBC approach, highlight the stages involved, the benefits, the implementation challenges and the various routine maintenance activities that are undertaken by road agencies in order to address the objectives of this research.

2.2 CONTRACT TYPES

For road maintenance works, there is often a need for contracts to cover a wider scope of work. For example: Algeria, Belgium, Brazil's DNER, British Columbia, Chile, Kenya, Malaysia and Pakistan use standard contract documents which may be different for major and minor maintenance works. Routine and periodic maintenance operations are sometimes contracted separately. This practice is used mostly in Chile, Kenya and Pakistan, and is applied frequently in other countries to more complex periodic activities, such as pavement or bridge repair work. In Algeria and Brazil, maintenance contracts for specific road sections combine execution of routine and minor periodic maintenance. (World Bank, 2001).

A contract with the private sector can be awarded on a cost base or price base. Cost base or cost-reimbursable contracts are contracts where the payments are based on actual costs (open book accounting) plus overheads and profit (sometimes including an incentive related to savings beyond the initial target costs) (Queiroz, 2000).

Price based contracts, preferred by highway agencies, can be:

- Lump sum - payment based on a single price for the total work
- Admeasurement - payment based on the quantity of completed work and tendered rates (bill of quantities)
- Performance-based contracts - payment based on performance (results) achieved.
- Hybrid Contracts

Source: Zietlow (2007) and Queiroz. (2000)

- **Unit Price Contracts (Admeasured)**

In this contract arrangement, road agencies require contractors to provide unit rates for work items to be executed. Payments under this contract are based on the quantity of work completed. (Zietlow, 2007)

- **Lump Sum Contract**

Under this arrangement the contractor is invited to tender on the basis of drawings and a specification. The contractor is responsible for assessing all the costs to be incurred in fulfilling the requirements on the drawings and in the specifications. Payment is based on single price for total work. (Zietlow, 2007)

- **Performance Based Contracts (PBC)**

This contract type involves the use of Performance Standards or Service Quality Criteria that will require fixed monthly payments if performance standards are complied with (Zietlow, 2007).

The delivery model for these contracts has in New Zealand, been developed around a 10 year lump sum contract structure. This long term contract tenure has provided the

contractor/consultant or consortium with a level of security concerning contract resources. They also have security in knowing what the long term financial commitments will be. Auditing for Performance compliance over this length of tenure becomes crucial to its success, as the client needs to know how the asset condition and service delivery is being maintained over the length of the tenure, (Hunter *et al.*, (n.d)).

Figure 2.1 illustrates the Contractual Relationships.

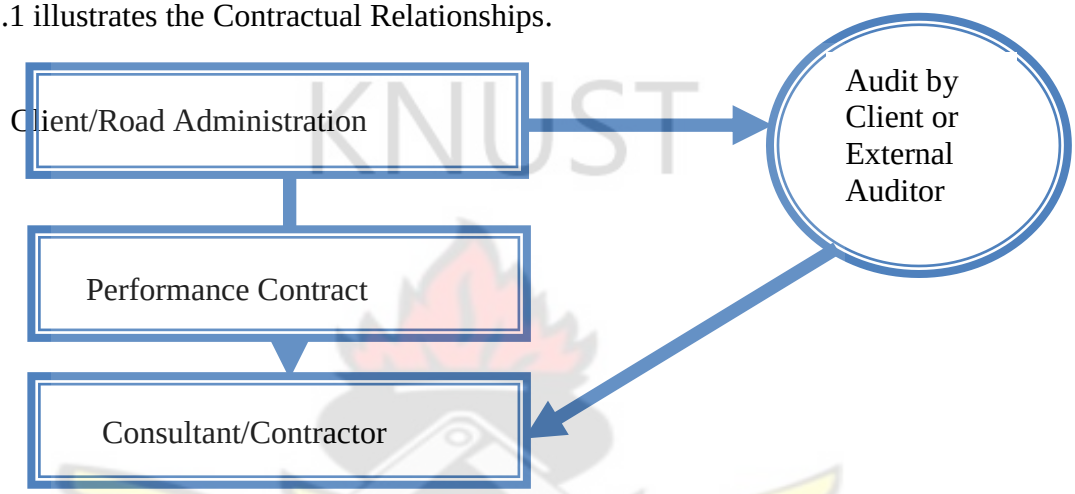

Figure 2.1: Contractual Relationship - PBC Model

Source: Zietlow 2007 & Hunter *et al.*, (n.d).

- **Hybrid Contracts**

This is the mixture of Performance based contracts and the Unit Price contracts.

In New Zealand, the development of the delivery model of the hybrid contracts has been considered as a stepping stone to the PBC model and may be most suited to network areas where contractors requires time to develop the alliances and experience necessary to successfully tender under PBC model. This model has been let with a 5-year tenure (2+1+1+1), with performance review target required to be met for annual roll over. Figure 2.2 illustrates this Contractual Relationship (Hunter *et al.*, (n.d).

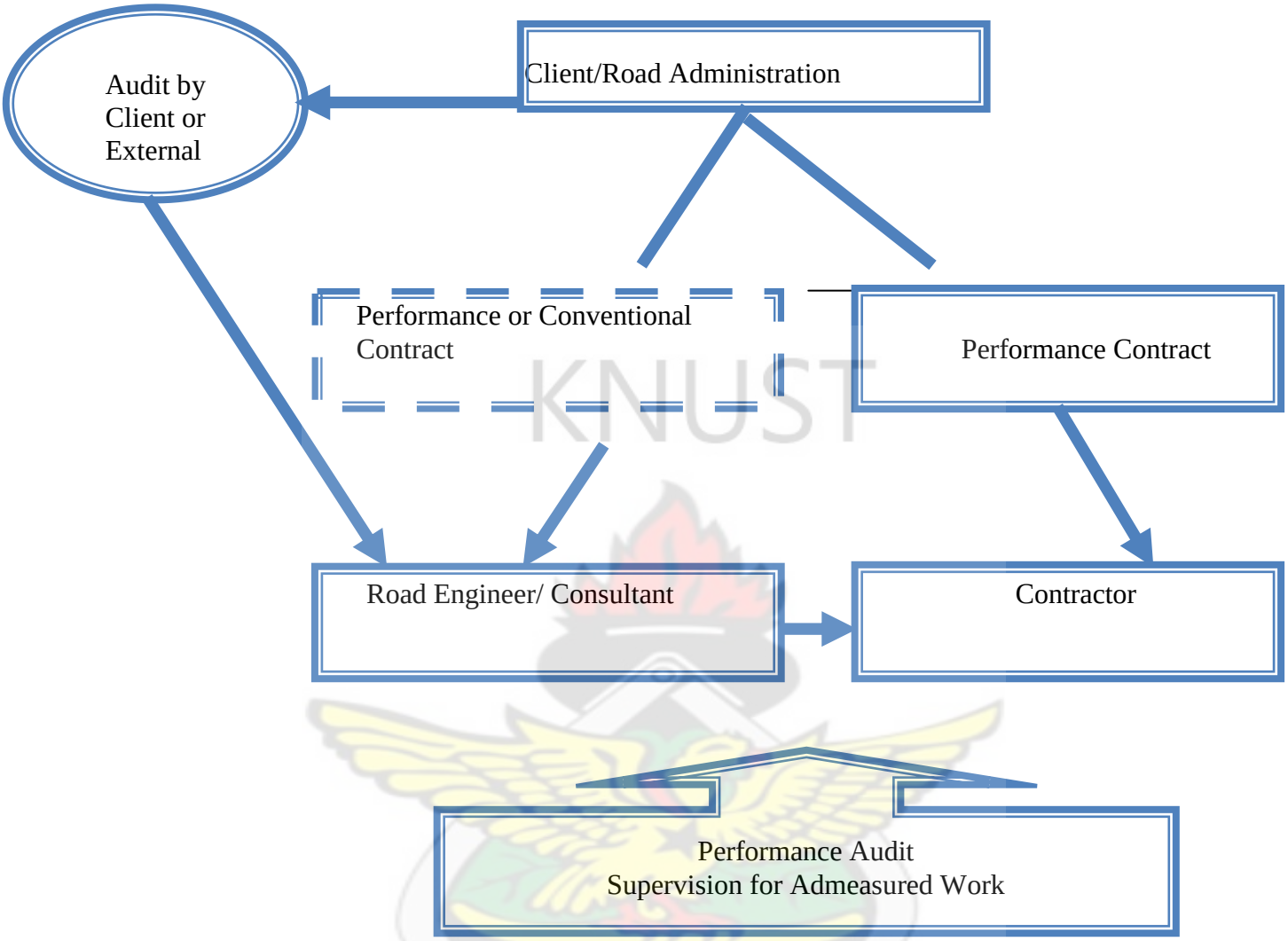

Figure 2.2: Contractual Relationship of the Hybrid Model

Source: Zietlow 2007 & Hunter *et al*., (n.d).

2.3. OVERVIEW OF PERFORMANCE-BASED CONTRACTS

Current best-practice techniques in outsourcing rely on performance-based specifications (Segal *et al.*, 2003). The most common form of how performance–based specifications are implemented in road maintenance is total asset management, or PBC. PBC calls for performance-based work in which a desired outcome is specified rather than a material or method. This approach differs significantly from traditional maintenance contracts,

which typically mandate the materials and techniques that must be used (Poster, 2001). Since PBC focuses on the final product and not on how it is achieved, these approaches normally define minimum conditions of roads, bridges, and traffic assets that a contractor must meet, as well as other services such as the collection and management of asset inventory data, attendance to emergencies, and response to public requests. In comparison to the traditional contract arrangement, this new contracting scheme allocates higher risk to the contractor, but at the same time opens up opportunities to reduce the cost of achieving the specified standards as a result of implementing new technologies, materials, processes and innovative management strategies (Zietlow, 2001).

2.3.1. Brief History of PBC

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

In 1995, Australia launched its first PBC to maintain urban roads in Sydney. Since then New South Wales, Tasmania, and Southern and Western Australia have started using performance-based and "hybrid" approaches (Zietlow, 2004).

In 1998, a PBC was introduced in New Zealand to maintain 405km of national roads (Zietlow 2004). At present, 15% of New Zealand's national network is covered under this type of contract (World Bank, 205).

A PBC was first introduced in the USA in Virginia State in 1996. Since then, four other states (Alaska, Florida, Oklahoma, Texas) and Washington, D.C. have started applying a PBC approach to maintain highways, bridges, tunnels, rest areas and urban streets, (FHWA, 2005).

In the developing world Latin America was the pioneer in developing and adopting its own performance-based contracting model. In 1995, Argentina introduced performance-based contracts, which at present cover 44% of its national network (Liautaud, 2004). In the mid nineties Uruguay also piloted PBC, first on a small portion of its national network and then on the main urban roads of Montevideo. Shortly thereafter, other Latin American countries, such as Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico and Peru, also started adopting a performance-based approach (World Bank, 2005). Gradually, this trend has spread to other developed and developing countries in Europe, Africa and Asia, e.g., UK, Sweden, Finland, Netherlands, Norway, France, Estonia (63% of national roads), Serbia and Montenegro (8% of national roads), South Africa (100% of national roads), Zambia, Chad (17% of all season roads), the Philippines (231km of national roads) (World Bank, 2005).

At present, preparations for launching PBC programs are underway in Albania, Cape Verde, Chad, Madagascar, Tanzania, Burkina Faso, India, Cambodia, Thailand, Indonesia, Vietnam and Yemen. Some of the above countries use "pure" performance based contracts, while others (e.g., Finland, South Africa, Serbia and Montenegro) use "hybrid" contracts (World Bank, 2005).

2.3.2 Scope, Assets and Services Covered by PBC

A PBC may cover either only individual assets (e.g., only traffic signs, only bridges) or all road assets (from right-of-way to right-of-way) within a road corridor (World Bank, 2005).

The level of complexity of a PBC can range from "simple" to "comprehensive" depending on the number of assets and range of services included. A "simple" PBC would

cover a single service (e.g., only mowing, only street light maintenance) and could be awarded for relatively short periods (several months or one year), (World Bank, 2005).

A "comprehensive" PBC would typically cover all road assets with the right-of-way and comprise the full range of services needed to manage and maintain the contracted road corridor. Such services would include routine maintenance, periodic maintenance and traffic accident assistance, etc. As periodic maintenance works (e.g. resurfacing, re-graveling) need to be repeated in a certain period, the contract tenure is usually from 3 years to 10 years and could go up to 30years. In a "comprehensive" PBC most of the works are often outsourced by the main contractor to subcontractors (World Bank, 2005).

Rehabilitation is not a compulsory component of a "comprehensive" PBC. Some road agencies include rehabilitation as part of the PBC; others choose to handle rehabilitation using traditional method-based approaches (World Bank, 2005).

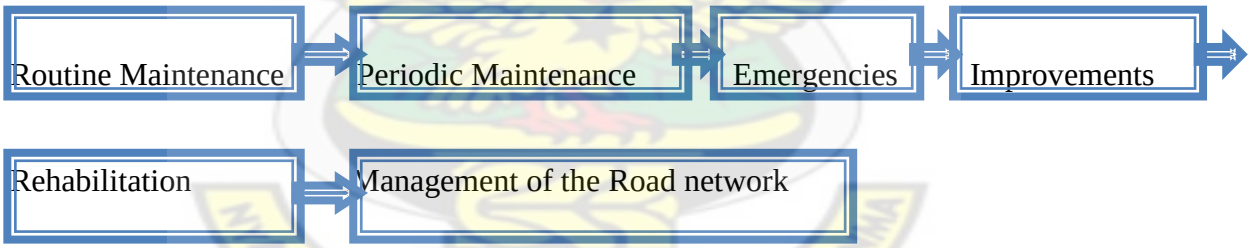

Figure 2.3: Scope of PBC increases from simple to more comprehensive tasks

(Source: Zietlow, 2007)

World Bank (2001), categorized for management and operational convenience, road maintenance as routine, periodic, and urgent/emergency works.

- **Routine works**. These are works that are undertaken each year that are funded from the recurrent budget. Activities can be grouped into cyclic and reactive works types. Cyclic works are those undertaken where the maintenance standard

indicates the frequency at which activities should be undertaken. Examples are verge cutting and culvert cleaning, both of which are dependent on environmental effects rather than on traffic levels. Reactive works are those where intervention levels, defined in the maintenance standard, are used to determine when maintenance is needed. An example is pothole patching, which is carried out in response to the appearance of cracks or pot-holes (World Bank, 2001)

- **Periodic works.** These include activities undertaken at intervals of several years to preserve the structural integrity of the road, or to enable the road to carry increased axle loadings. The category normally excludes those works that change the geometry of a road by widening or realignment. Works can be grouped into the works types of preventive, resurfacing, overlay and pavement reconstruction. Examples are resealing and overlay works, which are carried out in response to measured deterioration in road conditions. Periodic works are expected at regular, but relatively long, intervals. As such, they can be budgeted for on a regular basis and can be included in the recurrent budget. However, many countries consider these activities as discrete projects and fund them from the capital budget (World Bank, 2001).

- **Urgent/Emergency works.** These are activities whose need cannot be estimated with any certainty in advance. The activities include emergency works to repair landslides and washouts that result in the road being cut or made impassable. Winter maintenance works of snow removal or salting are also included under this heading. A contingency allowance is normally included within the recurrent budget to fund these works, although separate special contingency funds may also be provided (World Bank, 2001).

PIARC (1994), KCSWCD (1987), World Bank (2001) and DUR (2012) identified the following as the routine maintenance activities undertaken by Road agencies:

i) Grass cutting

This is undertaken to correct the defect of high vegetation such as grasses, weeds, bushes or trees that have been allowed to grow on the shoulders of road network (PIARC, 1994).

High shoulder vegetation if neglected will lead to the following:

- surface water can pond at the edge of the carriageway and weakening the pavement,
- silt accumulates at the edge of the carriageway,
- the visibility for road users is reduced, with increased risk of accidents with persons or animals,
- increased fire hazard in the dry season.
- overgrown trees or branches can fall and block the carriageway,
- the vegetation can block the drainage system or prevent it from being inspected or maintained, (PIARC, 1994)

ii. Cleaning of drainage structures/kerb

This activity is undertaken to clean or clear obstructions caused by vegetation growth, bushes, fallen trees, debris, loose silt or loose rocks in the drainage structures obstructing their functions. If neglected will cause blockage of the ditch or drain (PIARC, 1994).

iii. Desilting of drainage structures

This maintenance activity is undertaken to correct the defect of Silting, Sanding, and Blockage of drainage structures by debris. When the defect is neglected the result will be that the intended waterway opening will be so reduced that flood water cannot flow. It

will back-up or pond on the upstream side of the structure and may eventually over- flow the road embankment. The road is then in danger of being washed away (PIARC, 1994).

iv. Potholes patching/Sectional/Edge repairs.

These are defects in the pavement causing a noticeable impact on a car when ran over and are usually thought of as a hole in the roadway surface. They increase the roughness indices of road even when they are not patched well which results in increased Vehicle Operating Cost (VOC) (DUR, 2012).

v. Grading

Grading is a preventive maintenance activity done on unpaved road surface either engineered or not engineered to remove irregularities on the surface. It involves blading and reshaping of existing damage gravel surface, re-excavating earth ditches, and may include water and compact (PIARC, 1994).

vi. Erosion Control

This maintenance activity is carried out to correct surface water erosion on slopes and ditches. Surface water erosion which is caused by rainwater concentrated in to channels at the top of the slope and also lack of vegetation cover if neglected will lead to:

- deep erosion of the slope,
- slips
- obstruction of roadside ditch or shoulder (PIARC, 1994).

vii. Crack repairs

These are discontinuities that develop in bituminous surface dressed, asphaltic concrete or rigid pavements as a result of volume changes in the sub- grade or lack of material

friction in the base or the sub – grade. It can also be structural, thus due to excessive traffic loading (DUR, 2012).

viii. Minor drainage repairs

This routine maintenance activity is undertaken to prevent the collapse of the drainage structure. This activity looks at repairing damaged headwalls, aprons and sections of drains in order to reinstate them to perform the functions for which they were initially constructed to perform. It includes repairs of cracks on the drainage structures. (PIARC, 1994).

ix. Green area maintenance

This activity is carried out on routine bases to maintain green environment within the road corridor to certain minimum standards (PIARC, 1994).

x. Replacement of slabs and metal gratings

This routine corrective measure if neglected will result in open manholes or inspection chambers becoming a danger to people and animals. Vegetation and debris have uncontrolled access and blockage can occur (PIARC, 1994).

Sources: (PIARC, 1994; KCSWC, 1987; World Bank, 2001; DUR, 2012)

2.3.3 Key Differences between Traditional Method-Based and PBC

The idea that risks should be borne by the party that can manage them best is acknowledged in the literature, (Amos, 2004 and Quiroz 2000). What significantly differentiates a PBC is that the contractor is assigned a number of the responsibilities and risks that used to be borne by the owner agency under traditional method based contracts. On the one hand, the contractor is not tied down by the contracting agency in making his decisions regarding “what to do”, “when to do” and “how to do”. He is free to innovate

with techniques and technologies to reduce his own costs, as long as the level of service specified in the bidding documents is achieved (World Bank, 2004). On the other hand, the contractor now bears the entire risk in case of failure of his management and innovation– his errors in (i) predicting deterioration of contracted assets; (ii) determining appropriate design, specifications and materials; (iii) planning needed maintenance interventions; and (iv) estimating quantities (World Bank, 2004).

The selection process in performance-based contracting is normally based on "the best value", which may not be necessarily "the lowest bid". Since more risks and management responsibilities are carried by the contractor, the contracting agency wants to ensure management capacity with the potential contractor, his clear understanding of the new approach, the new responsibilities and his ability to handle the associated risks. The selection process involves choosing a contractor who has the capability to assess the condition of the assets, determine the timing of interventions, select materials and work methods, a suitable work plan and arrange the monitoring of his own services. Only after ensuring that the bidders are sufficiently qualified (normally through a pre-qualification process), does the selection process consider cost proposals. The "best value" approach tries to ensure a high quality product at a low overall cost (World Bank, 2005).

Payment in PBCs is made on a fixed price lump sum basis normally through uniform installments, linked to continuing performance targets. The contractor is not paid for physical works completed, but for the final results (or levels of service) he has delivered (World Bank, 2005).

The duration of PBCs is typically longer than that of traditional contracts as the contractor carries greater risk and responsibility and is obliged to undertake certain maintenance interventions that occur every few years (World Bank, 2005).

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

To be successful PBCs need a strong "partnering" philosophy. This is particularly critical in the initial stages when the PBC is being introduced, since neither the client nor the contractor has experience in this approach, and performance indicators and monitoring procedures are still evolving. Good communication is essential between the client, contractors and supervisor/engineer, to facilitate the discussion and prompt resolution of issues and concerns, so as to minimize the risk of future disputes and claims (World Bank, 2005).

2.3.4 Stages involved in PBC Process

Historically, the move towards performance-based maintenance contracts has originated from one of several sources: (i) higher levels of government, (ii) external financing agencies, or (iii) the private sector. This section describes the type of decision-making process needed to move towards a PBC approach (World Bank, 2005).

2.3.4.1 Development Stage: Initial Steps before the Implementation Phase

The road agency needs to clearly understand its main objective in adopting a PBC approach. These may be one or more of the following: (i) need to cut costs; (ii) implement higher level government directive; (iii) manage the road network with fewer staff; (iv) receive long-term funding for the maintenance program either from the government treasury or external financial sources that support a PBC approach; (v)

improve customer satisfaction; and (vi) in response to the private sector's offer to deliver more cost effective maintenance services. Depending on its main objective, the agency should determine the appropriate PBC format, i.e., extent (number of km) and tenure of the contract, types of services and range of assets to be outsourced, (World Bank, 2005).

Countries that have introduced performance-based road maintenance contracts have done it gradually, starting with one or two pilot projects to gain experience with administering this new type of contract (Zietlow 2001, Poster 2001, Segal et al. 2003). According to (Poster, 2001), before these agencies embark on such contractual arrangement, they must consider several elements to ensure positive results. An overview of those elements is presented as follows:

i) *Financial and Legal Aspects.*

Since PBC contracts are normally fixed price contracts and have contract durations between four and ten years, it is important for transportation agencies to secure financing for the entire contract period before starting such contracts, (Frost & Lithgow, 1996; Baker, 1999; Zietlow, 2001; Poster 2001). For example, one pilot project in Brazil had to be abandoned after only one year of operation due to a shortage of funds.

The selected PBC format needs to comply with the country's legal and regulatory framework. Some aspects of the contract format may be dictated by the prevailing environment. In this case, the agency may need to promote necessary changes to achieve the desirable format. In addition, it is also very important to verify the maximum contract period allowed by law. For example, in most countries in Latin America, the maximum contract duration is restricted to either four or five years, making it necessary to change laws in order to accommodate long-term contracts (Pinero, 2003).

The unionization level of the contracting industry needs to be taken into account. The prospective PBC format should not be perceived by the industry as depriving most contractors of business opportunities, while placing a privileged few in a dominant position. If the road agency prefers a "comprehensive" PBC, it is important to evaluate the level of collaboration between contractors and build in appropriate subcontracting opportunities for small- and medium-size firms. A single service PBC may be more appropriate in a less collaborative and unionized contracting environment. Either way, it is essential that the contracting industry be engaged at an early stage in the process of moving towards PBCs and appropriately consulted to adjust the format to suit local circumstances (World Bank, 2005).

ii) Geographic Scope.

One of the first decisions road administrators interested in implementing PBC contracts must make is to define the road network to be contracted out to the private sector. Normally, road administrations who implement this contracting scheme for the first time only select small networks as pilot projects. In addition to identifying the network to be outsourced to the private sector, several agencies also identify portions of the network that are still to be maintained by the road administration and that will be exposed to conditions similar to the roads maintained by the contractor (Baker, 1999; VDOT, 2000). By identifying these similar portions of the network, road administrators can perform a comprehensive comparison of the level of service at which each party maintains their assets. Some of the factors to consider in the identification of those similar portions of roads were: the geographical location, weather conditions, rural vs. urban settings, average traffic volumes, traffic mix, and types of assets in the routes (Pinero, 2005).

iii) Inventory and Condition of Assets to be maintained.

Once the portions of the network to be contracted are identified, most agencies create a complete list with all the assets for which the contractor is responsible. Identifying these assets is only the first step of the process. The next step and the most time-consuming is to create an inventory and condition assessment of all assets to be maintained by the contractor. This information is extremely important for the contractor to understand the asset conditions of road portions included in the contract (Pinero, 2003).

iv) *Performance Measures and Response Times.*

Since PBC are outcome-based contracts, road administrators define performance measures that specify the standards by which the contractor's maintenance work will be evaluated. Implementing agencies consider this a very challenging process. Some of the variables considered when defining such performance measures were: the asset type, the roadway system, and the traffic volume (VDOT, 1996; Frost & Lithgow, 1996, as cited in Pinero, 2003). Examples of some of the performance measures applied in different PBC contracts in Latin America and in Sydney, Australia are presented in Tables 2.1, (Gentili *et al.*, 1997; Zietlow 2001).

Table 2.1: Examples of Performance Measures used in Different PBMRC in Latin America

Asset Group	Component	Performance Target	Performance Measure
Pavement	Potholes	100%	No Potholes
	Roughness		IRI <2.0 (Argentina, IRI<2.8 (Uruguay
	Rutting		<12mm (Argentina) <10mm (Uruguay, Chile)
	Cracks		Sealed
Shoulders	Potholes	100%	No Potholes
	Cracks		Sealed
	Joints		Vertical Alignment < 1cm (Chile, Uruguay)
Drainage	Obstructions	100%	No obstructions, should allow for unhindered flow of water (Chile, Uruguay)
	Structures		Without damage and deformation (Chile)
Road signs and Road marking	Road signs	100%	Complete and clean, (Argentina, Chile)
	Road marking		Complete and visible (Argentina, Chile)
Right of Way	Vegetation	95%	<15cm height
	Foreign elements		No foreign elements allowed
Cross pipe < 36 ft.sq	Structurally sound	95%	<10% deteriorated barrel
	Open drains		>90% diameter open
	Joints Intact		Joints intact
	Adequate capacity		End protection intact
	No erosion		No dip in road over pipe
Paved Ditches	Aligned	95%	<1" settlement
	Structurally sound		<25% spalled
	Clean		No obstruction to flow of water
Sidewalks and Ramps	Smooth	90%	No settlement > ½"
	Safe		No unsealed cracks > 1/4"
	Sound		<25% spalled

(Source: World Bank, 2005)

v) Maintenance Activities.

The main idea behind PBC is that the contractor will be responsible for identifying the best means to achieve the desired asset conditions contained within the contract. However, in most existing PBC, road administrators require that these specific procedures be submitted for approval before implementing them. Implementing agencies require that all maintenance activities used by the private contractor are consistent with current specifications and standards. If the contractor recommends new treatments with unavailable standards, then the contractor must submit evidence and proper documentation of the expected benefits based on proper testing. According to (Poister, 1983) and (Poster, 2001), road administrators carefully considered several factors when evaluating approval of maintenance treatments recommended by private contractor. These factors include:

- Assure that the proposed maintenance treatment meets the criteria specified in the contract.
- Certify that the proposed maintenance treatment conforms to applicable standards.
- Assure that the proposed maintenance treatment will improve the long-term performance of the asset (Pinero, 2003).

vi) *Contractor Qualification Requirements.*

Existing performance-based contracts are essentially management contracts. According to implementing agencies, traditional road construction or maintenance contractors often do not have the required qualifications for this type of contract. Consulting firms with extensive experience in managing other contractors and experiences in pavement management systems that normally perform this kind of job. In Virginia, for example,

the performance-based contract is managed by VMS, which was formed by two consulting partners (VDOT 1996). Most of the maintenance work is subcontracted, allowing for efficient resource allocation (i.e., just-in-time principle). Joint ventures between road construction firms and consultants seem also to work well (Pinero, 2003).

2.3.4.2 Bidding and Implementation Stage

ii) Inventory of potentially contracted assets and determination of their condition.

Prior to developing an Invitation for Bids, the agency shall arrange the inventory and collection of data. It needs to: (i) accurately determine the conditions of the road assets to be contracted out; (ii) define performance indicators in the contract; (iii) undertake preliminary cost estimates; and (iv) specify a monitoring process. For performance indicators (See Table 2.1for details), (World Bank, 2005).

iii) Performance Indicators

Performance indicators shall be established for each asset to be contracted out. The selection and definition of indicators shall be based on (i) road user needs, (ii) the expectation of the client to have assets back on contract completion at the same level as they were contracted out or better, (iii) affordability, or the level of funding available. The agency shall avoid setting performance standards too high, since ambitious goals might significantly affect the bid price. Only a "vital few" performance indicators should be specified. The definitions of performance indicators should be simple, clear and easy to understand and achieve by the contractor (a 'SMART' approach can be applied in defining performance specifications: Specific, Measurable, Achievable, Realistic and Timely to schedule) (World Bank, 2005).

iv) Methodology to Measure Performance Indicators.

The agency needs to determine the methodology (i.e., methods and tools) which will be applied to measure performance indicators for each contracted service. It should be simple and inexpensive. The methodology should be clearly and accurately spelled out in the contract to prevent any misunderstanding from the contractor's side and avoid potential disputes. Within the "comprehensive" PBC, the contractor's performance is usually evaluated at the three levels: management, long term, and operational. Management performance indicators drive the planning, management and implementation aspects of the contract. They usually incorporate plans for quality, traffic, health, safety, and reporting requirements. Long-term (or key) performance indicators relate to the overall condition of the pavement, roughness, skid resistance, texture, rutting, surface life, structural conditions, etc. These drive the contractors' maintenance and rehabilitation interventions. Operational performance indicators apply to daily serviceability of the road network being maintained and include conditions of the pavements and road furniture (World Bank, 2005).

v) Payment Conditions.

The payment conditions shall be linked to the performance indicators spelled out in the contract. The contractor is paid a fixed price lump sum price in case of compliance with these indicators. Periodically, penalties for non-compliance shall be set for each indicator and deducted from scheduled payments to the contractor. Building in a reward mechanism in the contract is recommended to reward the contractor if he manages to retain or exceed the desired level of service for a sustained period. Such a mechanism provides an incentive to the contractor to innovate and deliver high standards (World Bank, 2005).

vi) Contract Conditions

As a PBC involves a significant shift in risk and management responsibilities to the contractor, the Conditions of Contract should clearly define the new roles of the client and contractor. They should clearly identify all potential risks and allocate these to the party that can manage them best. This applies, for example, to risks in predicting the growth in traffic and equivalent standard axles loads (ESALS), and risks for unpredictable costs under circumstances that are beyond the contractor's control (World Bank, 2005).

vii) Preliminary Cost Estimates

The agency shall prepare preliminary estimates for services to be contracted out under a PBC. The objective is to obtain a benchmark price for the contract against which bids will be compared later (World Bank, 2005).

viii) Bid Evaluation And Selection

Several criteria have been used for selection of contractors under PBC, based on: (i) price only or price and non-price criteria; (ii) prequalification of bidders or post-qualification; and (iii) joint evaluation of technical and cost proposals or short listing of bidders based on the evaluation results of technical proposals prior to the evaluation of cost proposals. If both price and technical criteria are taken into account, then the agency determines: (i) technical criteria to be applied; (ii) weight of technical criteria vs. price; and (iii) whether the winner will be selected based on the "low bid", highest score for the technical proposal or highest overall score for the both cost and technical proposals. Non-price criteria that have been used in PBC procurement include management team, relevant management and technical experience, past performance, methodology suggested and technical skills available (World Bank, 2005). Some examples of such criteria are provided in Table 2.2.

Due to the allocation of management responsibilities and risks to the contractor by a PBC, some countries opt for a "best value" approach in selecting a winner, arguing that the "low bid" approach does not ensure relevant experience and appropriate understanding of the PBC approach. However, these concerns can be addressed through appropriate pre- or post-qualification. Pre-qualification of bidders, based on clearly defined technical, financial, past experience, and other relevant criteria, is usually the preferred approach. The use of a consortium between contractors and consultants is encouraged because of the total asset management concept inherent in such contracts. The World Bank guidelines recommend that contracts be awarded to the bidder who meets the appropriate standards of capability and resources and whose bid has been determined (i) to be substantially responsive to the bidding documents and (ii) to offer the lowest evaluated cost (World Bank, 2004). Table 2.2 presents examples of Evaluation criteria adopted in evaluation of bids in Washington D.C., (World Bank, 2005).

Table 2.2 Evaluation criteria and their weight that were applied during the evaluation of bids in Washington, D.C., USA, 2000

Criterion	Description	Weight
Technical	Experience, Knowledge and understanding of issues relating to maintenance of the assets covered by this invitation for Bids. Soundness of technical approach for meeting the Performance measures for all of the assets	20%
Staffing, Quality Control/Quality Assurance Management	Staffing Plan	5%
	Management Plan	5%
	Quality Control/Quality Assurance Plan	5%
Past Performance	The extent to which the Prime Contractor's and subcontractors' Past Performance on similar asset maintenance and management contracts demonstrates on likelihood of successfully performing all of the tasks as set forth in this invitation for Bids	15%
Cost	The extent to what proposed costs are realistic and reflect the likelihood of overall cost to the government over the term of the contract	50%

Source: (Zietlow, 2001)

ix) Performance and Payment Security

Legislation in some countries may require performance security based on the value of the contract. In case of multi-year PBCs, this requirement may become a significant issue, since it could tie up a contractors' security capacity and restrict the number of potential bidders on other contracts. To overcome this problem, some countries started with shorter-term PBCs, whereas in others, authorities require either a two-year bond renewable annually (e.g., in Texas, USA) or one-year value bond (e.g., in Washington,

D.C., USA). The D.C. Department of Transportation considers the latter option sufficient, as it allows the agency to find another contractor, in case the incumbent defaults. Alternatively, contracts may provide for a percentage of each periodic payment to be held as retention money until final acceptance of the services (World Bank, 2005).

x) Risks Allocation for Unpredictable Costs.

In Virginia, USA, the contractor assumes the risk for unpredictable costs, including inflation, escalating material prices, accidents and force majeure events. In Argentina the contract allows reimbursement of cost overruns in certain circumstances, which are beyond the control of the contractor, such as earthquakes, hurricanes and bitumen shortage. The government uses the contractor's schedule of input prices submitted in the bid as a baseline for overruns estimates. The risk of excessive cost overruns is contained by a 25% cushion on these prices. In British Columbia, Canada, and Estonia performance based contracts include an annual price adjustment process that takes into consideration changes in price indices for labour and fuel (Zietlow, 2007).

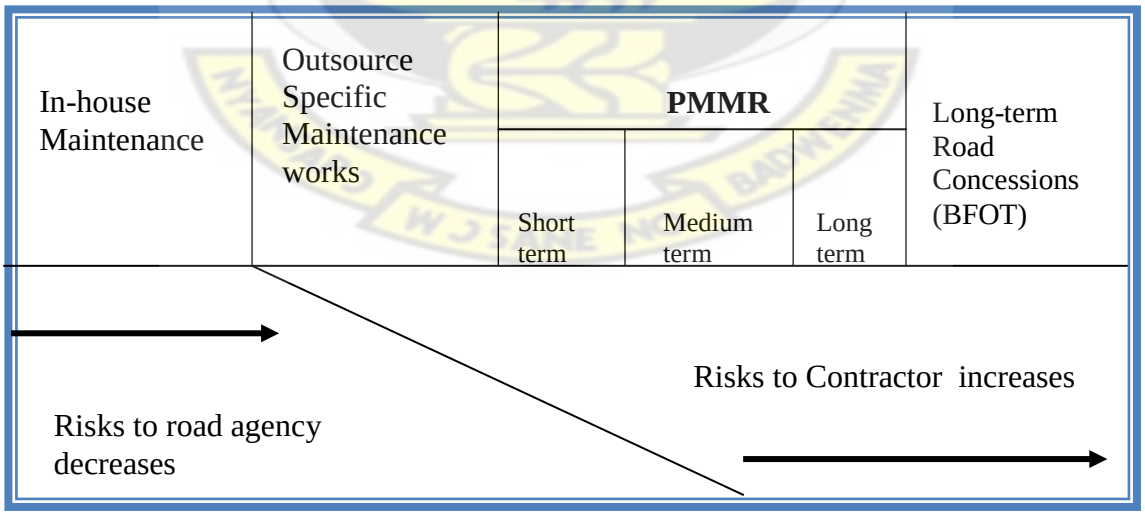

Figure 2.3: Distribution of Risks

Source: (Zietlow, 2007)

xi) Quality Assurance Program

Monitoring and evaluation of the contractor's performance shall be arranged to ensure the contractor's compliance with the performance specifications. The road agency shall determine the manner and frequency of monitoring inspections, composition of the joint inspection panel, partly responsible for arranging regular inspections, procedures of scheduling and arranging inspections, rules of selecting road segments to be tested, etc. Typically, the inspection panel consists of the representatives of each concerned party: agency, contractor and supervisor. As performance indicators set out in the PBC generally reflect road user needs, road users can also participate in performance monitoring to voice their concerns about the quality of service delivered (World Bank, 2005).

xii) Partnering

A partnering agreement shall be concluded between the agency, contractor and supervisor, as many PBC-related issues need attention from each party to ensure delivery of the desired level of service. This type of contract is not about "execution of the client's instructions", but about satisfying road user needs, which requires commitment from all involved. The partnering process allows the parties to establish more effective working relationships and better understand the associated risks. In some countries the partnership agreement is signed by management of the agency, contractors and supervising agency (World Bank, 2005).

2.3.5 Benefits of PBC as experienced in other Countries where PBC has been successfully implemented

According to (World Bank, 2005) review, road agencies that have adopted PBC approach have achieved:

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

Table 2.3 Cost Savings of Different Countries under PBC over the Conventional Contracts

Country	**Cost Savings , %**
Norway	About 20-40%
Sweden	About 30%
Finland	About 30-50% , about 5% less cost/km
Holland	About 30-40%
Estonia	20-40%
England	10% minimum
Australia	10-40%
New Zealand	About 20-30%
USA	10-15%
Ontario, Canada	About 10%
Alberta, Canada	About 20%
British Columbia, Canada	Some, but might be in the order of 10%

Source: (Pakkala, 2005)

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

iii. Reduction of the in-house workforce. For example, in Estonia, where 63% of the national network is under PBC, the workforce of the national and sub-national road agencies has declined, specifically from 2,046 (administration staff – 561, workers - 1,485) in 1999 to 692 employees (administration staff – 343, workers – 349) in 2003 (ENRA 2004).

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

v. Greater road user satisfaction. Road users appear to become more satisfied with the services delivered and the condition of the roads maintained under PBCs. No quantified results of improved road user satisfaction, reflecting PBC implementation have been reported to date, some agencies have noticed a decline in the number of complaints from road users. For example, in Chad "road users appreciate that the road is always in good conditions and not only after specific works were completed. Especially important

is that they can use the road in the rainy season, which was impossible before" (Zietlow 2004)

vi. Multi-year financing of a maintenance program. For example, by making the long-term payment obligations legally binding on the government, the CREMA contracts in Argentina have deterred the Treasury from failing to provide funding for road maintenance (Liautaud 2004).

Zietlow (2005), also Identified the Benefits of PBC as:

i. Expenditure certainty.

ii) Reduction of the in-house workforce.

iii) Reduction in workload

iv) Helps to assures long-term maintenance funding

v) Provides better transparency and accountability

vi) Improves customer focus

vii) Improves control and enforcement of quality standards

viii) Avoids frequent claims and contract amendments to increase quantities of work by the contractor

ix) Reduces road rehabilitation

x) Reduces risks

xi) Provides better and safer roads with consistent conditions

xii) Reduction of road user cost

xiii) Guarantees workload over longer period

Source: (Zietlow, 2005)

(Segal *et al.*, 2003), indicates that cities, counties, states, and the federal government outsource road and highway maintenance to achieve a number of goals, including:

i) Reducing costs;

ii) Increasing efficiency;

iii) Improving quality;

iv) Speeding project delivery;

Source: (Segal *et al.*, 2003)

v) Spurring innovation;

vi) Enhancing risk management; and

vii) Overcoming a lack of expertise.

Source: (Segal *et al*., 2003)

2.3.6 Implementation Challenges of PBC worldwide

World Bank (2005) identified the main challenges that road agencies face when introducing and expanding PBC and they include, but are not limited to the following:

i) Adequate allocation of risks to the party that is able to manage them best (World Bank, 2005).

ii) Establishing a "partnering" relationship between the contractor and client.

This requires a change in the road agency's mindset: from the role of a micromanager to the role of a strategic manager (World Bank, 2005).

iii) Need to acquire a new set of skills and expertise to enable the road agency staff to effectively develop and manage a PBC program (World Bank, 2005);

iv) Downsizing of the agency. Extensive adoption of the PBC approach may trigger the need to reduce the in-house workforce, since significantly less effort is needed to administer and supervise PBCs (World Bank, 2005).

v) Choosing a PBC format that is consistent with the contracting industry capacity available in the country (World Bank, 2005).

vi) Identification and clear definition of appropriate performance specifications. This requires good knowledge by the agency staff of how to establish the actual and desired condition of road assets - to specify achievable and realistic performance indicators for each contracted service (World Bank, 2005).

vii) Design of an incentive payment mechanism that encourages the contractor to consistently meet or exceed the specified minimum performance indicators (World Bank, 2005).

viii) Assured long-term funding for multi-year PBCs. In most countries the budgeting process is an annual exercise. This makes it virtually impossible to have total assurance about the funding for each year in a multi-year contract. However, this can be overcome by the political will to comply with the financial obligations assumed by the government when such contracts are signed. As construction contracts also usually extend beyond one year, the risks are similar for multi-year PBCs. The contracting road agency can mitigate these financial risks by giving priority in its budget proposals to contractual obligations relating to past years (World Bank, 2005).

ix) Determination of the liability and indemnity of the contractor and client, particularly, in relation to incidents, accidents and emergencies caused by force majeure events.

x) Commitment of higher level government;

xi) Adequate skills and expertise within the road agency;

xii) Appropriate capability of the contracting and consulting industries;

xiii) Enabling contracting and partnering environment;

xiv) Stable multi-year funding;

xv) Adapting the PBC generic principles and format to the specific local context of each country.

Source: (World Bank, 2005)

(Sultana *et al.,* 2012), also identified the following as the challenges that road agencies in developing countries face when introducing and expanding PBC:

i) Support from Government

Governments of developing countries have always given priority to construct new roads than maintaining existing ones. The construction project of building new roads seems to be more attractive than the maintenance of older one to draw the attention of general public. However, the implementation of PBC requires continuous government support towards this privatization approach due to the long-term nature of the performance-based maintenance contracts (Sultana *et al.*, 2012).

Governments in developing countries, who are already facing funding shortages in other sectors, hesitate to provide funding for long-term PBC at its early stage. Moreover, government shows interest for investing in long-term PBC approach only if the initial

cost of introducing PBC is supported by any external funding authority (Sultana *et al*, 2012).

ii) Dependency on External Funding

Getting support from an external authority can only be a temporary solution for developing countries as providing fund is mainly dependent on the donor's willingness to support the country. If the donors are not satisfied with the road authority or the government for any reason, they may suspend or cancel the loan.

Thus before introducing PBC in a developing country, the road authorities should ensure the source of internal funding as early as possible (Masuda, et al, 2012).

iii) Political Influence and Corruption

Political influence and corruption are the hardest obstacles for any new concepts to be implemented in developing countries. The selection of contractor for road maintenance works in developing countries is sometimes influenced by the political leaders. In PBC, road authority officials will supervise the site to check the performance of the contractors. If these officials would take bribes during these checks, the situation will be worse than ever. Contract documents are needed to be strictly prepared and implemented in PBC. Otherwise, there is no guarantee that PBC will be free of political influence and corruption in developing countries (Sultana *et al.*, 2012).

iv) Lack of Experience on and Knowledge of PBC

Inadequate experience on and knowledge of performance-based contracts is a great challenge for developing countries. The experienced personnel are required to decide the proper maintenance project, prepare all the relevant contract documents, set up the appropriate performance standard for the country, train the staff and contractors, and prepare the guidelines for the trial project of PBC (Sultana *et al.*, 2012).

v) Lack of Proper Planning

Another challenge for developing countries in the introduction of PBC is the lack of proper planning and managerial skills (Sultana *et al.,* 2012)

vi) Fear of Losing Job

One benefit of PBC is to reduce the number of staff in road authorities. However, the fear of losing jobs may refrain government staff in developing countries to support PBC. Government sector jobs are more secured than private sector jobs in some developing countries. The staff and union may not cooperate in implementing PBC due to these reasons (Sultana *et al.,* 2012).

vii) Loss of Competition

The number of contractors bidding in PBC type tendering is very few due to the high cost of tendering and bidding. This can reduce the competition among the contractors and increase the fear in small contractors of losing their work. However, small contractors can work together as a union to get jobs (Sultana *et al.,* 2012).

viii) Loss of Control of the Network

The road authorities have a common anxiety of losing the control over the network as PBC gives flexibility to the contractors to choose their own work methodologies. Failure in setting performance standards in the early stages of PBC can create a disastrous situation. The termination of the contract costs a significant amount of money and disputes in PBC compared to the traditional contracts which can be hard to handle for the road authority in a developing country (Sultana *et al.,* 2012).

ix) Performance and Attitude of Contractors

As PBC is depended on the performance on the contractors, the contractors must be capable enough to adapt the approach. The necessary training and information on the new contract should be provided prior to the implementation of PBC (Sultana *et al.*, 2012).

x) Challenges in Estimating the Cost

The successful implementation of PBC requires the proper estimation of costs. Contract terms, documents and performance standard will vary in different countries. As PBC is a long-term contract, it will not be possible to change anything once the contract has been started. However, developing countries faced difficulties in estimating costs at an early stage of implementing PBC as it is a very new concept for them (Sultana *et al.*, 2012).

(Hunter *et al.*, n.d), further identified the following factors considered to be critical to the achievement of the desired outcomes and is arguably generic across all delivery models (thus PBC model, Hybrid model and the Conventional model).

i) Tenure

Contract tenure that is long enough to permit the contractor/consultant to develop and retain the technical skills/resources necessary to ensure consistent delivery. However if this is too long or is not subject through on-going performance review, then there is the risk that, over time local competition may be lost. This would result in loss of future competitive pricing and output quality (Hunter *et al.*, n.d).

ii) Data Acquisition and Analysis

The acquisition and analysis of all of the available network data to determine when the most cost effective treatment is required to ensure network condition is maintained within the prescribed parameters. This requires detailed understanding of asset management at

the level at which these decisions are being made as well as strong systems based approach to support asset management personnel (Hunter *et al.*, n.d).

iii) Strategies

The development of strategies to promote efficient maintenance expenditure (Hunter *et al*., n.d).

iv) Monitoring

The ability to track and monitor the effectiveness of the strategies selected and report on trends and exceptions to the client through matching advanced systems and systems and personnel skill (Hunter *et al*., n.d).

v) Ownership

Network "ownership" at all levels. All parties must understand what the objectives are and are committed to achieving then (Hunter *et al.*, n.d).

vi) Skills

Personnel, who are technically skilled at the contract management level and just as importantly at the construction level. It will not be possible to achieve the required outcome if the technical and analytical decisions fail to be transformed into high quality workmanship in the field (Hunter *et al.*, n.d).

vii) Innovation

A continuing emphasis on innovation at all levels. If advances are to be achieved in terms of output efficient and quality, then there needs to be consistent examination of contract models used and work methods employed (Hunter, *et al.*, n.d).

viii) Communication

The development of contractual relationships (both internal and external) that maintain open and honest communication between all parties. Unless this achieved, it is probable that any delivery model will struggle to attain the required outcomes (Hunter *et al.*, n.d).

2.4 SUMMARY

This literature review has provided the background on important issues that must be considered when dealing with performance-based contracts, especially when they are used for road maintenance works. Various sources from literature identified benefits, challenges of implementing PBC and routine maintenance activities from experiences gathered worldwide and they are summarized as follows:

2.4.1 Benefits

i) Expenditure certainty.

ii) Reduction of the in-house workforce.

iii) Reduces workload

iv) Helps to assures long-term maintenance funding

v) Provides better transparency and accountability

vi) Improves customer focus

vii) Improves control and enforcement of quality standards

viii) Avoids frequent claims and contract amendments to increase quantities of work by the contractor

ix) Reduces road rehabilitation

x) Reduces risks

xi) Provides better and safer roads with consistent conditions

xii) Reduces road user cost

xiii) Guarantees workload over longer period

xiv) Provides potential for increased margins

xv) Opens excellent opportunities for business growth

Sources: (World Bank, 2005; Zietlow, 2005; Segal *et al.*, 2003)

2.4.2 Implementation Challenges

i. Adequate allocation of risks to the party that is able to manage them best.

ii. Establishing a "partnering" relationship between the contractor and client. This requires a change in the road agency's mindset: from the role of a micromanager to the role of a strategic manager.

iii. Need to acquire a new set of skills and expertise to enable the road agency staff to effectively develop and manage a PBC program;

iv. Downsizing of the agency. Extensive adoption of the PBC approach may trigger the need to reduce the in-house workforce, since significantly less effort is needed to administer and supervise PBCs.

v. Choosing a PBC format that is consistent with the contracting industry capacity available in the country.

vi. Identification and clear definition of appropriate performance specifications. This requires good knowledge by the agency staff of how to establish the actual and desired condition of road assets - to specify achievable and realistic performance indicators for each contracted service.

vii. Design of an incentive payment mechanism that encourages the contractor to consistently meet or exceed the specified minimum performance indicators.

viii. Assured long-term funding for multi-year PBCs. In most countries the budgeting process is an annual exercise. This makes it virtually impossible to have total assurance about the funding for each year in a multi-year contract. However, this can be overcome by the political will to comply with the financial obligations assumed by the government when such contracts are signed. As construction contracts also usually extend beyond one year, the risks are similar for multi-year PBCs. The contracting road agency can mitigate these financial risks by giving priority in its budget proposals to contractual obligations relating to past years.

ix. Determination of the liability and indemnity of the contractor and client, particularly, in relation to incidents, accidents and emergencies caused by force majeure events.

x. Support from Government

xi. Dependency on External Funding

xii. Political Influence and Corruption

xiii. Lack of Experience on and Knowledge of PBC

xiv. Lack of Proper Planning

xv. Fear of Losing Job

xvi. Loss of Competition

xvii. Loss of Control of the Network

xviii. Performance and Attitude of Contractors

xix. Challenges in Estimating the Cost

xx. Required legal and regulatory framework

Sources: (World Bank, 2005; Zietlow, 2005; Sultana *et al.*, 2012; Hunter *et al.*, n.d).

2.4.3 Routine Maintenance Activities

Also the literature identified the routine maintenance activities normally undertaken by road agencies and they include the following:

i. Grass cutting

ii. Cleaning of drainage structures/kerbs

iii. Desilting of drainage structures

iv. Potholes patching/Sectional/Edge repairs

v. Grading

vi. Erosion Control

vii. Crack repairs

viii. Minor drainage repairs

ix. Green area maintenance

x. Replacement of slabs and metal gratings

Sources: (PIARC, 1994; KCSWC, 1987; World Bank, 2001; DUR, 2012)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the various methods that were employed to meet the set research objectives. The overall objective of this research is to determine the critical benefits and challenges of introducing Performance Based Contracting for Road Maintenance Works in Ghana.

The study was specifically set out to:

i. Identify the benefits of using PBC approach

ii. Identify the Implementation Challenges of PBC approach.

iii. Identify routine maintenance activities that can be implemented using Performance Based Contracting approach

3.2 RESEARCH DESIGN

A cross sectional descriptive research design was adopted for this study, with the style being survey necessitating structured questionnaires with closed ended questions. The research approach was both qualitative and quantitative methods in nature. Detailed information was obtained to the useful conclusion.

3.2.1 Target population

The ten regional offices of the department of urban roads were taken as ten regional clusters. A census of all the ten regional clusters was used for the studies.

3.2.2 Sample and sampling technique

A judgmental sampling using purposive selection was adopted for this study with the objective of getting respondents who will be directly related to the subject of the study. The following key technical officers in charge of procurement and the implementation of procurement plans for road maintenance works were therefore selected from each regional office to form the sample size for the study:

- Regional Director (10 Directors from all 10 regions)
- Regional Maintenance Engineer (10 Maintenance Engineers from all 10 regions)
- Regional Quantity Surveyor (10 Quantity Surveyors from all 10 regions)
- Regional Development and Traffic Engineer (Present in only 5 regions - 1no. from each) See Appendix C for further details

The sample size for the study from the above summed up to 35 key technical staff.

3.2.3 Data collection and procedure

In collecting data for this research, primary and secondary data were used. The research was conducted using quantitative and qualitative research methods. Questionnaires were administered to the respondents to collect data. Respondents were given time to complete answering questionnaires as the researcher waited to collect them after the given response time was over. The questionnaires were pre-tested by giving 3 questionnaires to three of the potential respondents for piloting purposes.

3.2.4 Structure of Questionnaire

In order to achieve the objective of the study, close-ended questions were addressed to respondents to gather data. The questionnaires consisted of the following parts:

The first part of the questionnaire dealt with the demographic data of the respondents, here the age group, profession, as well as professional association, job position of the respondent was sought and finally the number of years that he/she has been in the road construction industry. This was meant to establish the credibility of responses from respondents.

The second part focused on the expected benefits of implementing Performance Based Contracting for road maintenance works in Ghana. It provided a list of 17 expected benefits that would be accrued to the agency for implementing a PBC approach. A scale of 1 to 5 was provided to measure the extent to which respondents agree to the list of expected benefits. The objective here was to identify the benefits to the road agency if PBC is implemented.

The main objective of the third section looked at identifying routine maintenance activities that can easily be implemented using PBC. This section provided a list of 10 routine maintenance activities with an allowance for respondents to add to the list other routine maintenance activities that were not included in the questionnaire. A scale of 1 to 5 was again provided to measure the extent to which respondents agree to the list of routine maintenance activities.

The final part of the questionnaires consisted of implementation challenges of PBC for road maintenance works in Ghana was provided as section four of the questionnaire. A scale of 1 to 5 was provided to measure the level of significance of each factor to the

respondent, where "1" meant Insignificant "2" Slightly significant "3" Quite Significant "4" Very Significant "5" Extremely Significant. See Appendix A for the detailed format of the questionnaire.

For clarity on the subject of the questionnaire, a preamble was provided in the questionnaire to briefly refresh the minds of the respondents on the subject. Since PBC is relatively a new approach to the road agencies in the country.

3.2.5 Distribution of Questionnaires

The questionnaires were distributed by posting to the respective respondents. All the respondents were given the freedom to answer and rate the factors in a manner that they deemed fit.

3.3 DATA ANALYSIS

For the data analysis, the research employed Descriptive statistics, t-test sampling technique, Relative Importance Index (RII), and Comparison of means (One- way Anova technique) to analyse survey data.

3.3.1 Relative Importance Index (RII)

Relative importance index (RII) = $\frac{\sum w}{AxN}$ (Source: Badu et al, 2013)

Where w = the weighting given to risk by the respondents and ranges from 1 to 5

A = The highest weight = 5

N = The total number in the sample

Example: Consider the rating scale of 1 to 5; 1. Strongly disagree, 2. Disagree 3. Not Sure 4. Agree 5. Strongly Agree

Factors	Scores					Weighting	RII	Rank
	1	2	3	4	5			
Responses for Factor No. 1	0	0	2	4	6	52	0.87	1

The weighting (w) = [(1x 0) + (2x0) + (3x2) + (4x4) + (6x5)] = 52

The highest weight (A) = 5 (Strongly agree)

N= Total number of respondents for that factor = 12

Hence RII = 52/ (5x12) = 0.87

This formula was used in chapter 4 to analyse data obtain in respect of part 2 of the questionnaires on routine maintenance activities.

3.3.2 Descriptive statistics

The descriptive statistical tools employed for this research were mainly frequencies and percentages. These analytical tools were used to analyse background data of respondents.

3.3.3 One Sample t-test

The relative significances of the variables were determined using the one-sample t-test. According to Ahadzie (2007), the one sample t-test is normally used to establish whether a sample mean is significantly deviant from a hypothesized mean. A hypothesized sample mean (test value) of 4.00 was fixed by considering its position on the likert scale which was from Agree to strongly agree. This analytical tool was used analyse data on expected benefits of PBC.

3.3.4 Comparison of Means (One-Way Anova)

To be able to analyse the extent of the relationships of responses from the categories of respondents concerning factors, A ONE- WAY ANOVA was used to cast inference on the calculated mean scores and standard deviations to determine the extent of agreement among the four groups of respondents. The aim was to find the relationship among the positions of respondents identified in the study scope. This technique was used to analyse the factors that will affect the successful implementation of PBC.

3.4 SUMMARY

This chapter addresses the research methodology of this study, explain the sample selection, describe the procedure used in designing the instrument and collecting the data, and provide an explanation of the statistical procedures used to analyze the data. The next chapter is devoted to the analysis and discussion of the survey results

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

After the review of literature and the theories underpinning the study, this chapter dealt with the analysis of the data collected and consequently, discusses the findings in relation to established positions by different authors in the discipline. The first section of the chapter encompasses the background of the respondents and the second section is dedicated to the analysis and discussion of the dependent variables. The statistical tools adopted for the analyses include descriptive, relative importance index and the comparison of means (One-way Anova). Out of the thirty-five (35) administered questionnaires, thirty-one (31) were retrieved representing 88.57%. This formed the basis of the discussion of the findings as presented in this chapter.

4.2 BACKGROUND OF THE RESPONDENTS

The section is dedicated to the discussion of the results pertaining to the background of the respondents. Such analysis includes inter alia gender of the respondents, age group, profession, professional membership. It considered that such discussion elucidate further discussion on the dependent variables and adds credibility to the information obtained as a result.

4.2.1 Gender of the Respondents

Out of the 35 respondents targeted, 31 responded to the questions with twenty-three (28) of them indicating that they were males whereas the remaining three were females (see Figure 4.1. This finding somewhat agrees with the general perception that female retention in the construction industry is low.

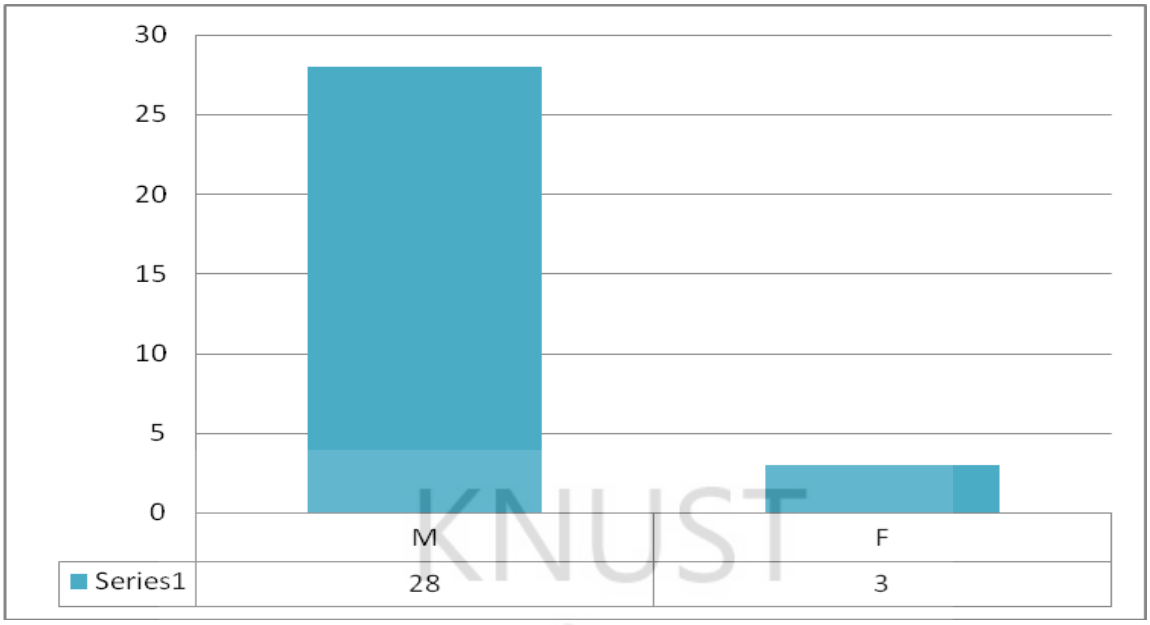

Figure 4.1 Gender of Respondents

Source: Field survey, 2014

4.2.2 Age Group of Respondents

The respondents were asked to indicate their age group, and out of the total respondents, majority representing 71% belonged to the age group 25-40 years while 29% of the respondents belong to 41-55 years group. This results shows that majority of the key technical staff of the department of urban roads have their ages ranging from 25years to 40years.

Table 4.1 Age group of Respondents

Years	Frequency	Valid Percent	Cumulative Percent
25-40yrs	22	71	71
41-55yrs	9	29	100.0
Total	31	100.0	

Source: Field survey, 2014

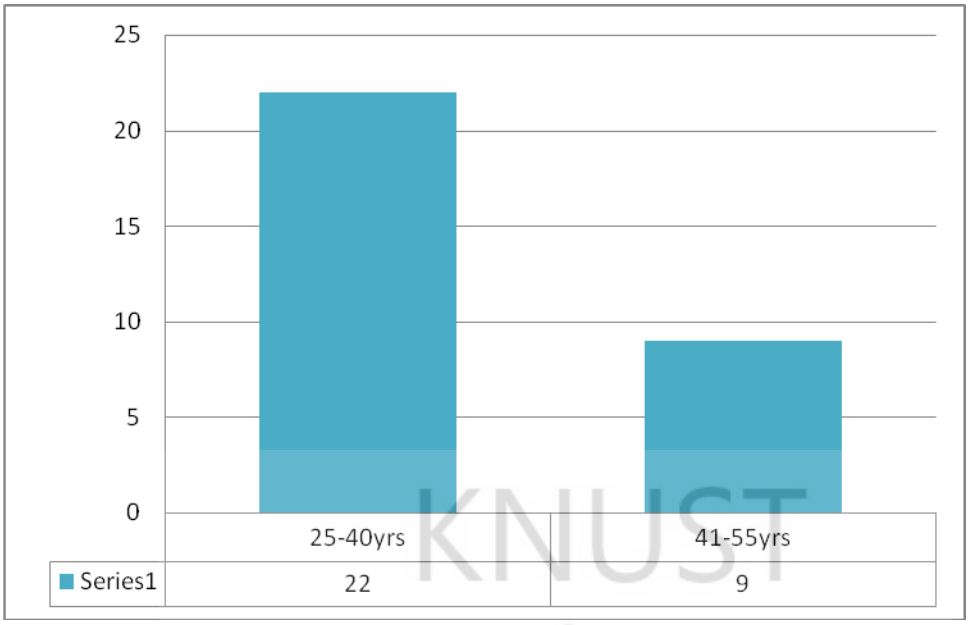

Figure 4.2: Age Group of Respondents

Source: Field survey, 2014

4.2.3 Profession of Respondents

Subsequently, the respondents were asked to indicate their profession. From the survey, two basic professions were identified – Quantity Surveyor and Civil Engineer. 67.7% were Civil Engineers and 32.3% were Quantity Surveyors. The table below shows the breakdown of the results. These results show that the procurement practitioners within the department of urban roads are mainly civil engineers and quantity surveyors.

Table 4.2 Profession of Respondents

Profession	Frequency	Valid Percent	Cumulative Percent
Civil Engineer	21	67.7	67.7
Quantity Surveyor	10	32.3	100.0
Total	31	100.0	

Source: Field survey, 2014

4.2.4 Professional Membership

Professionals are required, ideally, to belong to memberships or associations. Such membership promotes the profession and enhances the potentials of the members. Thus, clients and the public alike are given the assurance regarding the job practices of the profession. Also, Continuous Professional Development (CPD) is also provided by such agencies. In the construction industry, such associations and professional bodies exist; among them include Ghana Institute of Architects, Ghana Institution of Planners, Ghana Institution of Surveyors and Ghana Institution of Engineers. However, the respondents surveyed belonged to mainly two of these professional bodies. 67.7% belonged to the Ghana Institute of Engineers (GhIE) whereas 32.3% belonged to the Ghana Institute of Surveyors (GhIS) (Refer to Fig. 4.3).

Professionals' professional ability is guaranteed by their membership of professional institutions. The professional membership of the targeted respondents was therefore critical to the quality of the data that was being obtained. Hence the results of the analysis shows that the data that was obtained had the quality required and can be relied upon since all the respondents' either belonged to Ghana Institution of Engineers or Ghana Institution of Surveyors.

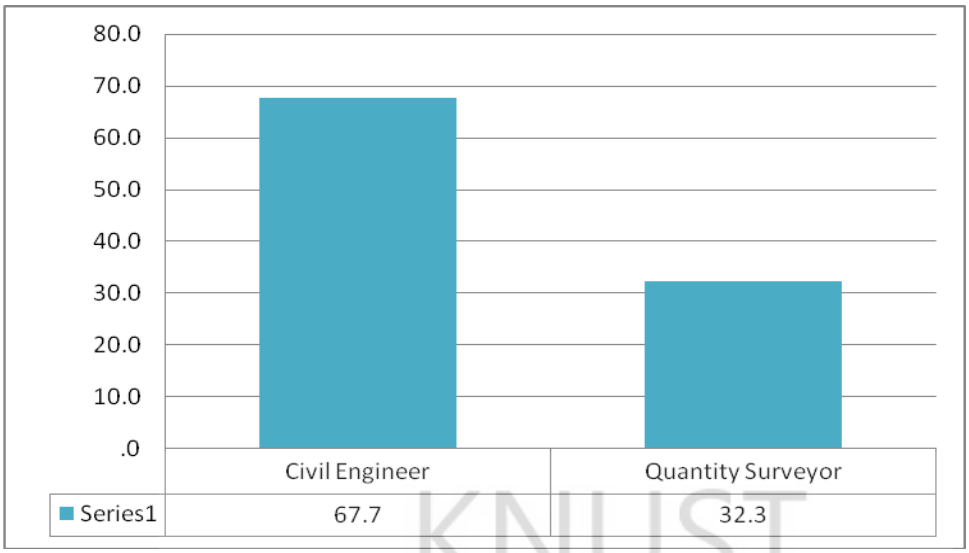

Figure 4.3: Professional Membership of Respondents

Source: Field survey, 2014

4.2.5 Position of Respondents

As already indicated the target respondents were professionals in the ranks of Regional Maintenance Engineer, Regional Quantity Surveyor, Regional Director and Regional Development/Traffic Engineers. This section was dedicated to the analysis of questions pertaining to the position of the respondents. It considered that such analysis would validate the responses of the respondents as they fall within that category. 32.3% of the respondents were Regional Maintenance Engineers whereas, another 32.3% being Regional Quantity Surveyors, 19.4% being Regional Directors. The remaining 16.1% of the respondents were Regional Development/Traffic Engineers. See Table 4.3 below for details. The position of a respondent was critical to the objectives of the study since it shows the extent to which he or she can influence decision making at the agency. Therefore the fair distribution of the various positions from the finding enhances the reliability of the response obtained.

Table 4.3 Position of Respondents

Position	Frequency	Valid Percent	Cumulative Percent
Regional Director	6	19.4	19.4
Regional Maintenance Engineer	10	32.3	51.6
Regional Quantity Surveyor	10	32.3	83.9
Regional Development/Traffic Engineer	5	16.1	100
Total	31	100.0	

Source: Field survey, 2014

4.2.6 Years of Experience in Road Construction

The number of years of experience invariably determines amongst other things the number and forms of contracts undertaken. Also, the challenges presented with the forms of contracts involved also provide somewhat insight to the best possible ways of solving them. Thus, the years of experience influences the kind of information given. As a result, participants were required to indicate their years of experience. 5 respondents out of the 31 respondents had working experience '1-5' years, 9 had '6-10' years working experience. Similarly, 11 respondents had '11-15' years working experience whilst the remaining 6 had '16 and above' years of experience in road construction (See Fig. 4.4).

With the majority of the respondents had working experiences above 10 years indicating that most respondents had been in the sector for quite a long time and can contribute meaningfully to the objective of the study.

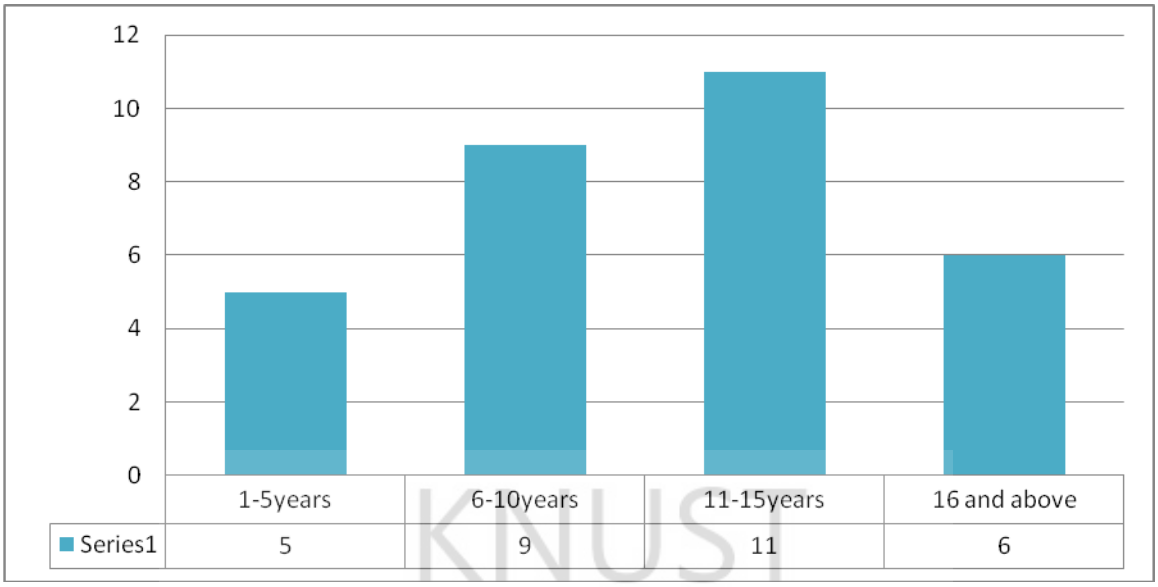

Figure 4.4: Years of Experience of Respondents

Source: Field survey, 2014

4.3 ONE SAMPLE TEST OF BENEFITS OF IMPLEMENTING PERFORMANCE BASED CONTRACTING FOR ROAD MAINTENANCE WORKS IN GHANA.

Before the implementation of any policy or regulation the benefits are analysed against the potential challenges. The policy is only implemented when it is found to have relatively more potential benefits than the challenges. As a result, this section looked at the benefits of implementing Performance Based Contracting for road maintenance works in Ghana. In view of this seventeen factors were identified from literature and respondents were asked to rate them according to the extent to which they agree with the factors as benefits on a five-point likert scale items (1. Strongly disagree 2. Disagree, 3. Not sure, 4. Agree and 5. Strongly agree).

In analysing the results of the benefits, this research was interested in the order of significance of benefits of implementing Performance Based Contracting for road maintenance works in Ghana. Hence, in establishing the relative significance of the

variables the one-sample t-test was used. According to Ahadzie (2007), the one sample t-test is normally used to establish whether a sample mean is significantly deviant from a hypothesized mean. The hypothesis for a single sample –test is typically set thus:

Ho: U=Uo

Ha: U<, >Uo

Where, Ho denotes the null hypothesis, Ha denotes the alternative hypothesis and Uo denotes the hypothesized or population mean. In a typical one-sample-test, the mean of the test group, degree of freedom for the test (which approximates the sample size), the t-value (which is an indication of the strength of the test) and the p-value (i.e. the probability value that the test is significant) are commonly reported (see for instance, Ahadzie, 2007; Field, 2005; Hair *et al*., 1998; Reymont *et al*, 1993).

Subsequently, a statistical t-test of the mean carried out to determine whether the population considered a specific benefit to be significant or otherwise. The mean ranking of each benefit tabulated to help elucidate the consensus reached by the respondents. A summary of the test results presented in Tables 4.4 to 4.6.

The mean for each variable including the associated standard deviation and standard error presented in Table 4.4. For each variable, the null hypothesis was that the criterion was not significant (Ho: U= Uo) and the alternative hypothesis was that the criterion was significant (Ha: U>Uo), where Uo is the population mean. Thus Uo represented the critical rating above which the criterion considered significant. Given that the rating adopted ascribed higher ratings of 4 and 5 to Agree and Strongly Agree criterion, Uo was therefore fixed at an appropriate level of 4.00.

The significance level was also set at 95% in accordance with orthodox risk levels (see for instance Ahadzie, 2007 and Ling, 2002). That is, based on the five-point Likert scale rating, a success criterion deemed significant if it had a mean of 4.00 or more. Where two or more criteria have the same mean, the one with the lowest standard deviation assigned the highest significance ranking (see for instance Ahadzie, 2007; Field, 2005; Shen and Liu, 2003).

According to Ahadzie (2007), the standard error is the standard deviation of sample means as well as a measure of how likely a sample represents the population. Hence, a large standard error (relative to the sample mean) suggests that there is a lot of variability between means of different samples. A small standard error suggests that most sample means are similar to the population mean, therefore the sample is likely to be an accurate reflection of the population (Ahadzie, 2007; Field, 2000; 2005). The standard error associated with all the means is relatively close to zero suggesting that the sample chosen is an accurate reflection of the population (Table 4.4). With the exception of Most of the mean scores the benefits were greater than 4.00 with suggesting that all the challenges identified are significant.

Table 4.4: Results of t-test showing one-sample statistics

Benefits	N	Mean	Std. Deviation	Std. Error Mean
Result in cost savings	31	4.4615	.58177	.11410
Enhance expenditure certainty	31	4.2692	.72430	.14205
Reduce the workload	31	4.1154	.99305	.19475
Reduce the in-house workforce	31	3.9615	.77360	.15172
Help to assure long-term maintenance funding	31	4.2692	.77757	.15249
Provide better transparency and accountability	31	4.1538	.61269	.12016
Improve customer focus	31	4.0385	.82369	.16154
Improve control and enforcement of quality standards	31	4.3846	.80384	.15765
Avoid frequent claims and contract amendments to increase quantities of work by the contractor	31	4.2308	.86291	.16923
Reduce road rehabilitation	31	4.1154	1.03255	.20250
Reduce risks	31	4.1154	.71144	.13953
Provide better and safer roads with consistent conditions	31	4.2308	.71036	.13931
Reduce road user cost	31	4.2308	.86291	.16923
Guarantee workload over longer period	31	3.8846	.95192	.18669
Provide potential for increased margins	31	4.0769	.79614	.15614
Opens excellent opportunities for business growth	31	4.1154	.81618	.16007
Easy to implement	31	3.6154	.98293	.19277

Source: Field survey, 2014

As shown in the Table 4.4, the standard deviations are all less than (1.0) indicates that there is little variability in the data. Alternatively, standard deviation values of less than (1.0) indicated consistency in agreement among the respondents of the reported level of results (see for instance, Field, 2005; Steven, 1996).

However, variable such as ***Reduce road rehabilitation*** obtained a standard deviation greater than (1.0) (refer to Table 4.4) indicating that respondents interpreted the variables in their own ways resulting in variability in the agreement. Further discussion on the t-test below provides plausible explanation for this. The significance (i.e. p-value) of each attribute is displayed in Table 4.5. The p-value is for a two-tailed test, however as shown per the test hypothesis, what is of interest here is one-tailed test (i.e. U >Uo). Subsequently, the "sig." value in Table 4.5 has been divided by two and the summary listed in Table 4.6.

Table 4.5: Results of one-sample Test showing test significance

	Test Value (Uo) = 4.00					
					95% Confidence Interval of the Difference	
Benefits	t	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Result in cost savings	4.045	30	.000	.46154	.2266	.6965
Enhance expenditure certainty	1.895	30	.070	.26923	-.0233	.5618
Reduce the workload	.592	30	.559	.11538	-.2857	.5165
Reduce the in-house workforce	-.254	30	.802	-.03846	-.3509	.2740
Help to assure long-term maintenance funding	1.766	30	.090	.26923	-.0448	.5833
Provide better transparency and accountability	1.280	30	.212	.15385	-.0936	.4013
Improve customer focus	.238	30	.814	.03846	-.2942	.3712
Improve control and enforcement of quality standards	2.440	30	.022	.38462	.0599	.7093
Avoid frequent claims and contract amendments to increase quantities of work by the contractor	1.364	30	.185	.23077	-.1178	.5793
Reduce road rehabilitation	.570	30	.574	.11538	-.3017	.5324
Reduce risks	.827	30	.416	.11538	-.1720	.4027
Provide better and safer roads with consistent conditions	1.656	30	.110	.23077	-.0562	.5177
Reduce road user cost	1.364	30	.185	.23077	-.1178	.5793
Guarantee workload over longer period	-.618	30	.542	-.11538	-.4999	.2691
Provide potential for increased margins	.493	30	.627	.07692	-.2446	.3985
Opens excellent opportunities for business growth	.721	30	.478	.11538	-.2143	.4450
Easy to implement	-1.995	30	.057	-.38462	-.7816	.0124

Source: Field survey, 2014

Table 4.6 Summary of t-test showing rankings and results of 1-tailed test

Benefits	Mean	Std. Deviation	Sig. (1-tailed)	Ranking
Result in cost savings	4.4615	.58177	.000	1
Enhance expenditure certainty	4.2692	.72430	.035	3
Reduce the workload	4.1154	.99305	.280	10
Reduce the in-house workforce	3.9615	.77360	.401	14
Help to assure long-term maintenance funding	4.2692	.77757	.045	4
Provide better transparency and accountability	4.1538	.61269	.106	7
Improve customer focus	4.0385	.82369	.407	13
Improve control and enforcement of quality standards	4.3846	.80384	.011	2
Avoid frequent claims and contract amendments to increase quantities of work by the contractor	4.2308	.86291	.093	6
Reduce road rehabilitation	4.1154	1.03255*	.287	11
Reduce risks	4.1154	.71144	.208	8
Provide better and safer roads with consistent conditions	4.2308	.71036	.055	5
Reduce road user cost	4.2308	.86291	.093	6
Guarantee workload over longer period	3.8846	.95192	.271	15
Provide potential for increased margins	4.0769	.79614	.314	12
Opens excellent opportunities for business growth	4.1154	.81618	.239	9
Easy to implement	3.6154	.98293	.029	16

Note: *shows high inconsistency in its agreement

Source: Field survey, 2014

The findings as ranked in the table above indicates that most of the variables are significant benefits of implementing Performance Based Contracting for road maintenance works in Ghana. However, a handful of the variables were identified not to be significant indicating they obtained mean values less than 4.00. Overall, ***Result in cost***

savings was ranked first and ***Easy to implement*** was also ranked last amongst the benefits.

4.3.1 Result in cost savings

The implementation of Performance Based Contracting (PBC) for road maintenance works and road works in general has been found to result in cost savings. Typical examples are in the USA and New Zealand. In the USA, the USA Virginia Department of Transportation is realised to pay amounts in excess of about $20,000 per mile per year under PBC, Similar situation is also found in the New Zealand which results in a decrease in the professional fees and also more than 10% reduction in the physical works. Generally, the findings agree with the works by several authors on PBC that found the major benefit to be a massive reduction in cost, which can go as high as a 40% decrease (see for instance FHWA 2005; Liautaud 2005; Pakkala, 2005). The variable obtained a mean value of 4.4615 significantly higher than the hypothesized mean and accordingly was ranked first by the respondents' altogether.

4.3.2 Improve control and enforcement of quality standards

The variable was ranked second by the respondents and thus obtained a mean value of 4.3846 significantly higher than 4.00 i.e. the hypothesized mean. It also attained a standard deviation lower than 1.00 indicating that there was no variability in the response of the respondents. The findings somewhat confirms the results of Zietlow (2005) that also proved ***improve control and enforcement of quality standards***as a benefit of the implementation of PBC in road projects. It understands as contractors are reimbursed their cost as and when they perform. Consequently, contractors are particular of the project and keen to deliver knowing their payments are tied to the performance. All the necessary things are thus done to improve the quality standards of the projects.

4.3.3 Enhance expenditure certainty

Once the works are defined there is expenditure certainty. From the word go, the cost to be reimbursed the contractor is determined from the expected deliverables of the project. This is one benefit other forms of contract for most maintenance of road projects lack. Like the aforementioned benefits the respondents also ranked ***Enhance expenditure certainty*** as significant benefit of PBC implementation. It, therefore, obtained mean and standard deviation of (4.2692) and (0.72430) respectively. As identified by Zietlow (2005), the finding confirms this as significant benefit of PBC.

4.3.4 Easy to implement

To successfully implement any new plan would require the acquisition of expertise in that discipline, strengthening of structures to receive such new ideologies, continuous education among other awareness creation. All these require resources and are also cumbersome. The ability to foresee clearly and define the deliverables of the projects even somewhat defeats its implementation. It was, therefore, not surprising the variable was ranked as the least benefit among the seventeen variables.

4.4 ROUTINE MAINTENANCE ACTIVITIES THAT CAN BE IMPLEMENTED USING PBC

Subsequently, it was necessary to establish from the respondents the routine maintenance activities that can be governed with PBC in Ghana. Respondents were thus asked to rate the activities to indicate the extent to which it can be governed with. In the analysis of the extent of their agreement to the various maintenance activities for which PBC can be implemented on, the Relative Importance Index (RII) together with standard deviation and mean score were used. The aim of the analysis was to establish the relative significance of the maintenance activities on which PBC could be implemented (for e.g.

Fugar et al, 2010). The score of each factor is calculated by summing up the scores given to it by the respondents (for instance see Badu *et al.,* 2013; Fugar *et al*, 2010). For a five-point response item, RII produces a value ranging from (0.2 – 1.0) (cf Badu *et al.,* 2013; Ugwu et al, 2007). Based on the five-point likert scale, variables with Mean greater than (4.00) are considered important. In the calculation of the Relative Importance Index (RII), the following formula was used (Badu *et al.,* 2013):

$$RII = \frac{\Sigma W}{A * N}$$

Where, W: weighting given to each statement by the respondents and ranges from 1 to 5; A – Higher response integer (5), and N – total number of respondents. The standard deviation indicates the level of consistency of the responses given.

Table 4.7 Routine Maintenance Activities

Routine Activities	Mean	Std. Deviation	Weighting	RII	Ranking
Grass cutting	4.3846	.69725	114	0.876923	5
Cleaning of drainage structures/kerbs	4.5769	.50383	119	0.915385	1
Desilting of Drainage structures	4.5385	.50839	118	0.907692	2
Potholes Patching/Sectional/Edge repairs	4.4615	.85934	116	0.892308	4
Grading	4.1538	1.04661*	108	0.830769	6
Erosion Control	3.7308	1.04145*	97	0.746154	10
Crack repairs	3.9615	.87090	103	0.792308	7
Minor drainage repairs	3.8077	1.32723*	99	0.761538	9
Green area maintenance	4.5385	.58177	118	0.907692	3
Replacement of slabs and metal gratings	3.7692	1.21021*	101	0.776923	8

Note: *shows high inconsistency in its agreement

Source: Field survey, 2014

From the table 4.7 above, the highest ranked variable was *cleaning of drainage structures/kerbs* suggesting that it is the maintenance activity that PBC can be used on relatively easier amongst the ten (10) activities. The variable had a mean value of 4.5769 and a standard deviation of (0.50383) whilst attaining RII of (0.9154). The weighting also gave an indication of the relative success of the implementation of PBC on such a project.

This activity is undertaken to clean or clear obstructions caused by vegetation growth, bushes, fallen trees, debris, loose silt or loose rocks in the drainage structures obstructing their functions. If neglected will cause blockage of the drainage structures.

Subsequently, *Desilting of Drainage structures* which a maintenance activity is undertaken to correct the defect of Silting, Sanding, and Blockage of drainage structures by debris was also ranked second with a mean value of 4.5385. Thus, it can be concluded that after cleaning of drainage structures, the next routine maintenance activity that easily supports the implementation of PBC is Desilting of drainage structures. Also, *Green area maintenance* was found to be one of the activities that easily allow the use of PBC. The variable ranked third amongst the total variables obtaining a mean and RII of (4.5385) and (0.907692) respectively. Green area maintenance basically refers to the greening of the environment within the road corridor.

Potholes a Patching/Sectional/Edge repair was subsequently ranked fourth by the respondent's altogether. Such maintenance activities are of utmost importance to any road network since they have the tendency of causing road accidents and increasing the vehicle operating cost (VOC) due to high roughness indices of roads. Hence, activities like that require the needed attention required of them and the deliverables achieved with strict adherence to specifications. In lieu of that PBC can be used on such routine activities.

And also this form of contract has been found to be used on potholes patching in Latin America achieving a hundred percent desired results (see for example Zietlow, 2004).

Grass cutting also obtained mean and RII values significantly higher. For instance it obtained a mean value of (4.3846) which is exceedingly greater than the hypothesized mean. With such activities, the contractor works according to the defined performance measures established by the road administrators. Grass cutting has that element of been able to establish the deliverables from the start and thus make it more appropriate for the implementation of PBC on such activities.

4.5 ONE-WAY ANOVA OF FACTORS FOR THE SUCCESSFUL IMPLEMENTATION OF PBC FOR ROAD MAINTENANCE WORKS IN GHANA

Having known the benefits of PBC on road maintenance projects, gone through the routine maintenance activities that are suitable for the implementation of PBC, it was deemed imperative to establish among the four categories of respondents, the relationship among their responses regarding the factors for the successful implementation of PBC for road maintenance works in Ghana. As part of the data collection, information was elicited from four main classes of respondents. Section 4.2.5 discussed these classes of respondents.

In the analysis of the extent of the relationship in their responses concerning these factors A ONE- WAY ANNOVA was used to cast inference on the calculated mean scores and standard deviations to determine the extent of agreement among the four groups. The aim was to find the relationship among the positions of respondents identified in the study scope. In this case, the test statistic has an F sampling distribution with df1 and df2

degrees of freedom at a significant level (α) of 0.05 (5%). The analyses and results of the investigation are presented (Tables 4.8) and discussed in this section.

Null Hypothesis (H_o): There is no difference between positions about the variables for the successful implementation of PBC

Alternative Hypothesis (H_a): There is significance difference between positions about the variables for the successful implementation of PBC

Table 4.8: One-way Anova of factors for the successful implementation of PBC for road maintenance works

Factors		Sum of Squares	df	Mean Square	F	Sig.
Allocation of Risk to the party that is able to manage them	Between Groups	4.585	3	2.292	1.967	.163
	Within Groups	26.800	27	1.165		
	Total	31.385	30			
Establish a partnering relationship between the contractor and the client	Between Groups	2.328	3	1.164	.659	.527
	Within Groups	40.633	27	1.767		
	Total	42.962	30			
Need to acquire new set of skills and expertise	Between Groups	3.846	3	1.923	1.053	.365
	Within Groups	42.000	27	1.826		
	Total	45.846	30			
Downsizing of the agency	Between Groups	7.605	3	3.803	3.654	.042
	Within Groups	23.933	27	1.041		
	Total	31.538	30			
Choosing a PBC format that will be consistent with the contracting industry capacity available in the country	Between Groups	1.513	3	.756	.715	.500
	Within Groups	24.333	27	1.058		
	Total	25.846	30			

Identification and clear definition of appropriate performance specifications	Between Groups	1.805	3	.903	2.133	.141
	Within Groups	9.733	27	.423		
	Total	11.538	30			
Design of incentive payment mechanism	Between Groups	2.882	3	1.441	3.405	.051
	Within Groups	9.733	27	.423		
	Total	12.615	30			
Assured of long-term funding for multi-year PBC	Between Groups	3.005	3	1.503	2.652	.092
	Within Groups	13.033	27	.567		
	Total	16.038	30			
Determination of the liability and indemnity of the contractor and the client	Between Groups	.728	3	.364	.319	.730
	Within Groups	26.233	27	1.141		
	Total	26.962	30			
Support from Government	Between Groups	1.282	3	.641	.675	.519
	Within Groups	21.833	27	.949		
	Total	23.115	30			
Dependency on external funding	Between Groups	5.282	3	2.641	3.142	.062
	Within Groups	19.333	27	.841		
	Total	24.615	30			
Political influence and corruption	Between Groups	3.928	3	1.964	1.050	.366
	Within Groups	43.033	27	1.871		
	Total	46.962	30			
Lack of Experience on and knowledge of PBC	Between Groups	1.154	3	.577	.354	.706
	Within Groups	37.500	27	1.630		
	Total	38.654	30			
Lack of Proper planning	Between Groups	1.538	3	.769	.786	.467
	Within Groups	22.500	27	.978		
	Total	24.038	30			

Fear of losing job	Between Groups	.985	3	.492	.324	.726
	Within Groups	34.900	27	1.517		
	Total	35.885	30			
Loss of Competition	Between Groups	9.128	3	4.564	2.971	.071
	Within Groups	35.333	27	1.536		
	Total	44.462	30			
Loss of control of the network	Between Groups	6.154	3	3.077	2.212	.132
	Within Groups	32.000	27	1.391		
	Total	38.154	30			
Performance and attitude of contractors	Between Groups	3.405	3	1.703	1.470	.251
	Within Groups	26.633	27	1.158		
	Total	30.038	30			
Challenges in estimating the cost	Between Groups	1.282	3	.641	.357	.704
	Within Groups	41.333	27	1.797		
	Total	42.615	30			
Legal and regulatory framework	Between Groups	1.767	3	.883	.688	.513
	Within Groups	28.233	26	1.283		
	Total	30.000	29			

Source: Field survey, 2014

Summarily, for most of the variables as presented herein in table 4.8, the decision was to reject the null hypothesis since the F values were greater than the sig. values. Thus, in concluding it is established that there is significant difference between the agreements of the respondents in the identified positions regarding the factors that can serve as impetus for the implementation of PBC.

However, only a handful of variables experienced the opposite to the above. Such variables had F values to be less than the sig. values suggesting no difference between the

agreements of the various respondents. The variables included *Determination of the liability and indemnity of the contractor and the client, Challenges in estimating the cost, Fear of losing job, and Lack of Experience on and knowledge of PBC.*

4.5.1 Allocation of Risk to the party that is able to manage them

Decision: Reject H_o since F calculated (1.967) is greater than significant value (0.163) and conclude that there is significant difference between the agreements of respondents in the four positions on the factors that successfully motivates the implementation of PBC. The implication was that ***Allocation of Risk to the party that is able to manage them*** is phenomenal in the implementation of PBC for road maintenance works in Ghana. World Bank (2005) and Masuda et al (2012) identified it as a challenge in which when resolved can lead to the successful implementation.

4.5.2 Downsizing of the agency

Similarly, the decision was to Reject H_o since F calculated (3.654) is greater than significant value (0.042) and conclude that there is significant difference between the agreements of respondents in the four positions on the factors that successfully motivates the implementation of PBC. Thus, the respondents agree that in order to successfully implement PBC on road maintenance works, the number of in-house professionals must be cut-down since the effort required to administer such contracts is less. This ultimately would lead to lay-off of workers as a result of the redundancy and this has been identified as a major challenge given the prevailing economic conditions (see World Bank, 2005; Masuda, et al, 2012).

4.5.3 Fear of losing job

Decision: Accept H_o since F calculated (0.324) is less than significant value tabulated (0.726) and concludes that there is no significant difference between the agreements of the different respondents in the four positions on the factors that successfully motivates the implementation of PBC. This suggests that among the respondents in the four positions, they argued that Fear of losing jobs significantly influences the success of the implementation of PBC for road maintenance works. Another beneficial side of PBC mentioned in the literatures is to reduce the number of staff in road authorities. This goes to confirm a survey by Masuda et al (2012), that the benefit of downsizing the agency work force meant job losses. Fear of losing jobs may refrain government staff in developing countries to support PBC as Government sector jobs are more secured than private sector jobs in these areas. Government prior to implementing PBC will have to engage labour unions on its numerous benefits including the creation of secured jobs in the private sector as it opens excellent opportunities for business growth.

4.5.4 Design of incentive payment mechanism

Decision: Accept H_o since F calculated (3.405) is less than significant value tabulated (0.051) and concludes that there is significant difference between the agreements of the different respondents in the four positions on the factors that successfully motivates the implementation of PBC. This suggests that among the respondents in the four positions, they argued that Design of incentive payment mechanism significantly influences the success of the implementation of PBC for road maintenance works. This confirms the World Bank (2005) review that **Design of an incentive payment mechanism** that encourages the contractor to consistently meet or exceed the specified minimum performance indicators is a key factor required for the successful implementation of PBC.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter, the research was concluded by summarizing the issues that have thoroughly been discussed throughout the study. Additionally, an overview of how the research objectives were attained is presented followed by the main conclusions of the study. The study is finally ended with recommendations and direction for further research based on the limitations and conclusion of the study.

5.2 SUMMARY OF FINDINGS

The main aim of this research, as noted previously, was to identify the expected benefits, implementation challenges of Performance Based Contracting for Road Maintenance works in Ghana and to also identify routine maintenance activities that can easily be implemented using this approach.

In achieving this aim, three objectives were outlined. They are:

- Identify the benefits of using PBC approach.
- Identify the Implementation Challenges of PBC approach
- Identify routine maintenance activities that can easily be implemented using Performance Based Contracting approach.

A methodological approach involving a literature review process, a questionnaire development and administration stage and finally a data analysis section using important indices to rank the PBC on road maintenance works, a one-sample t-test to determine the significance of the benefits of PBC and A ONE-WAY ANOVA to analyse the factors that

aid in the successful implementation of PBC, were used. Here, the research objectives are revisited to highlight the extent to which they were attained through the various stages of the research.

5.2.1 OBJECTIVE 1: Identify the benefits of using PBC approach

Subsequently, this objective was addressed by establishing from literature the benefits PBC has brought in road projects. In all, seventeen benefits were identified from literature, (Segal, et al, 2003; World Bank, 2005 and Zietlow, 2005). Respondents were then asked to rate their level of significance on a likert scale of 1 to 5. The analysis was therefore imperative in the identification of the significant benefits of PBC. Over all, fourteen (14) were found to be significant whereas the remaining three (3) were found by the respondents to be less significant.

5.2.2 OBJECTIVE 2: Identify the Implementation Challenges of PBC approach

The second objective was realised through the reviewing of literature to identify the potential implementation challenges of PBC. Works by World Bank (2005), Masuda et al (2012), Hunter, et al, (n.d) formed the basis of this objective. Twenty (20) implementation challenges which when surmounted would automatically lead to the successful implementation of PBC in road maintenance works in Ghana. Here, various views among the four classes of respondents were analysed to validate the relationship of their agreement. Out of the twenty (20) variables, there was no significant difference between the groups on sixteen (16) of the variables.

5.2.3 OBJECTIVE 3: Identify routine maintenance activities that can easily be implemented using Performance Based Contracting approach.

This objective was satisfied by identifying the routine maintenance activities that can be implemented using PBC approach. And out of the ten (10) identified routine activities from literature, it was realised four (4) would not be easy to implement using PBC whereas the remaining six (6) showed that they can be implemented easily using PBC.

5.3 CONCLUSION

As noted throughout the study, the implementation of PBC on many road maintenance projects has yielded the desired results leading to some extent as high as 40% cost savings. This benefit together with other potential benefits has been confirmed by this study to be very significant benefits that the road agency and the country as a whole stand to gain if PBC is implemented. Notwithstanding the survey results that indicated that the benefit of PBC as an approach that can "easily be implemented" was less significant as a benefit, the prospects of implementing PBC are very high for road agencies and the country as a whole and far outweigh the surmountable implementation challenges. It is evident from literature that countries that have implemented this approach have managed to overcome these challenges and are continuously recording significant achievements.

5.4 RECOMMENDATIONS

However, the benefits are yet to be exploited by the participants and the general public alike in the Road Construction Industry in Ghana. As a result, this study was conducted to identify the expected benefits and challenges of implementing Performance Based Contracting for Road Maintenance Works in Ghana. Against this backdrop, the following recommendations are set forth.

- **Routine Maintenance Works should be awarded on PBC.**

From the findings and the literature it became clear that routine maintenance works are easily implemented using PBC and when monitored and evaluated the benefits can be mouthwatering. However, there were few outliers. Notwithstanding, the majority of the routine maintenance works came out strongly to be possible with the adoption of PBC.

- **Allocation of Risk to the party that is able to manage them**

Also, it was established that the holistic allocation of risk and the ability of the participants to manage such allocated risks is impetus to the successful implementation of PBC on road maintenance projects. It is thus recommended that risk assessment must be conducted to adequately and effectively allocate risks among the project participants.

- **Need to acquire new set of skills and expertise**

Projects are only as successful as the level of expertise of the participants of the projects. Thus, existing workers must upgrade their skills and the right expertise obtained for the successful implementation of PBC. Identification and clear definition of appropriate performance specifications requires good knowledge by the agency staff of how to establish the actual and desired condition of road assets - to specify achievable and realistic performance indicators for each contracted service. This is done through awareness creation, CPD, government support and workshops and seminars for agency staf, etc.

- **Legal and Regulatory Framework**

The need to create a legal and regulatory frame work such as developing the standard bidding documents and the establishment of performance standards for the implementation of PBC is critical for the successful implementation of this contracting method.

- **Political Influence and Corruption**

Political influence and corruption are significant obstacles for any new concepts to be implemented in developing countries. It is therefore recommended that contract documents are needed to be strictly prepared and implemented in PBC. Otherwise, there is no guarantee that PBC will be free of political influence and corruption in developing countries.

5.5 LIMITATION OF THE STUDY

As with every survey based research there are bound to be limitations which need to be acknowledged. It is important to acknowledge the relative small sample size used for the study. Consequently, analyses of the dependent variables were constrained by the fact that those variables with mean less than the hypothesized mean is subjective; and the possibility that the mean scores may change when a larger sample size is chosen. Notwithstanding, the demographic profile of the respondents suggest that they have reasonable experience in this research area which should generate some credibility in the responses received.

5.6 DIRECTIONS FOR FUTURE STUDY

This concept is still in its early stage and has huge potential and scope of work for future researchers. The potential of reducing maintenance costs, increasing the quality of works and reducing the chance of corruption in the long run in developing countries are the challenging issues for PBC, which needs more attention.

The study limitation spurred new areas to be explored. These areas need further research attentions. The following areas have been suggested for future studies:

- A more holistic approach must be adopted to include the contractors involved in road maintenance works.
- More so, the current study employed quantitative research design. Qualitative study can thus also be performed in order to possibly develop a framework for the engagement of PBC.
- Further research can be carried out on the challenges discuss in this paper to implement PBC successfully in the country

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APPENDICES

APPENDIX A: QUESTIONNAIRE

The essence of this questionnaire is to collect data on the expected Benefits and Challenges of implementing a Performance Based Contracting for Road Maintenance Works in Ghana.

Please kindly respond to the questions by ticking ☑ the appropriate option in the box provided for each question and write briefly where required. Please note that all information provided will be treated strictly as confidential as this work is purely for academic purposes.

1. **Demographic data**

i. Sex ❑ M ❑ F

ii. Age group

❑ under 25yrs ❑ 26 – 40yrs ❑ 41 – 55yrs ❑over 56yrs

iii. Profession of respondent:

❑ Civil Engineer ❑ Quantity Surveyor ❑Materials Engineer ❑ Other

If other, please state……

iv. Professional Membership

❑ Ghana Institution of Surveyors ❑ Ghana Institution of Engineers ❑ Other

If other, please state……

v. Position……..……

vi. Years of working experience in the Road Construction Sector

❑ < 1 year ❑ 1-5years ❑ 6-10years ❑ 11- 15years ❑ 16 and above

PREAMBLE

Performance-based contracting (PBC) is a type of contract in which payments for the management and maintenance of road assets are explicitly linked to the contractor successfully meeting or exceeding certain clearly defined minimum performance indicators. It is often referred to as outcome-based contracting. This is because the contract puts the responsibility on the contractor by specifying the end result desired by the agency. The contractor has the free ability to decide when to start work and the equipment to use as long as the performance specifications are met. This is different from method-based contracting which specifies how and when the contractor is to do the work. These contracts span for multiple years with an option to renew.

Payments for this type of contractual relationship are made for measured outputs instead of the traditional way where the measurement and payment reflects the quantity of input. For example, the contractor is not paid for the number of potholes he has patched, but for the output of his work.

2. Expected Benefits of PBC

Will the above contracting approach:

Use the scale: 1. Strongly disagree 2. Disagree 3. Not sure 4.Agree 5 Strongly agree

	Question	**1**	**2**	**3**	**4**	**5**
i	Result in cost savings					
ii	Enhance expenditure certainty					
iii	Reduce the workload					
iv	Reduce the in-house workforce					
v	Help to assure long-term maintenance funding					
vi	Provide better transparency and accountability					
vii	Improve customer focus					
viii	Improve control and enforcement of quality standards					
ix	Avoid frequent claims and contract amendments to increase quantities of work by the contractor					
x	Reduce road rehabilitation					
xi	Reduce risks					
xii	Provide better and safer roads with consistent conditions					
xiii	Reduce road user cost					
xiv	Guarantee workload over longer period					
xv	Provide potential for increased margins					
xvi	Opens excellent opportunities for business growth					
xvii	Easy to implement					

AdditionalComments……

……

……..

3. Routine Maintenance Activities

Can Performance Based Contracting approach be implemented easily on the following Routine maintenance activities?

Use the scale: 1. Strongly disagree 2. Disagree 3. Not sure 4. Agree 5. Strongly agree

	Routine Maintenance Activities	**1**	**2**	**3**	**4**	**5**
i	Grass cutting					
ii	Cleaning of drainage structures/kerbs					
iii	Desilting of Drainage structures					
iv	Potholes Patching/Sectional/Edge repairs					
v	Grading					
vi	Erosion Control					
vii	Crack repairs					
viii	Minor drainage repairs					
ix	Green area maintenance					
x	Replacement of slabs and metal gratings					
	Others not included in this list					

Additional

Comments……

……

……

4. Implementation Challenges of Performance Based Contract

How significantly will the following issues affect the successful implementation of Performance Based contracting in your agency?

Use the scale: 1. Insignificant 2. Slightly Significant 3. Quite Significant

4. Very Significant 5. Extremely Significant

	Issues	**1**	**2**	**3**	**4**	**5**
i	Allocation of Risk to the party that is able to manage them					
ii	Establish a partnering relationship between the contractor and the client					
iii	Need to acquire new set of skills and expertise					
iv	Downsizing of the agency					
v	Choosing a PBC format that will be consistent with the contracting industry capacity available in the country					
vi	Identification and clear definition of appropriate performance specifications					
vii	Design of incentive payment mechanism					
viii	Assured of long-term funding for multi-year PBC					
ix	Determination of the liability and indemnity of the					

	contractor and the client					
x	Support from Government					
xi	Dependency on external funding					
xii	Political influence and corruption					
xiii	Lack of Experience on and knowledge of PBC					
xiv	Lack of Proper planning					
xv	Fear of losing job					
xvi	Loss of Competition					
xvii	Loss of control of the network					
xviii	Performance and attitude of contractors					
xix	Challenges in estimating the cost					
xx	Legal and regulatory framework					

Additional Comments……..……...

THANK YOU VERY MUCH

APPENDIX B: ORGANOGRAM OF A TYPICAL DEPARTMENT OF URBAN ROADS REGIONAL OFFICE

APPENDIX C: COMPOSITION OF SELECTED STAFF OF DEPARTMENT OF URBAN ROADS FOR THE STUDY

COMPOSITION OF SELECTED STAFF OF DEPARTMENT OF URBAN ROADS

NO	REGION	POSITIONS
1	Greater Accra	Regional Director
2	"	Regional Maintenance Engineer
3	"	Regional Development/Traffic Engineer
4	"	Regional Quantity Surveyor
5	Western	Regional Director
6	"	Regional Maintenance Engineer
7	"	Regional Quantity Surveyor
8	Upper West	Regional Director
9	"	Regional Maintenance Engineer
10	"	Regional Quantity Surveyor
11	Upper East	Regional Director
12	"	Regional Maintenance Engineer
13	"	Regional Quantity Surveyor
14	Northern	Regional Director
15	"	Regional Maintenance Engineer
16	"	Regional Quantity Surveyor
17	Brong Ahafo	Regional Director
18	"	Regional Maintenance Engineer
19	"	Regional Development/Traffic Engineer
20	"	Regional Quantity Surveyor
21	Volta	Regional Director
22	"	Regional Maintenance Engineer
23	"	Regional Development/Traffic Engineer
24	"	Regional Quantity Surveyor
25	Eastern	Regional Director
26	"	Regional Maintenance Engineer
27	"	Regional Development/Traffic Engineer
28	Central	Regional Director
29	"	Regional Maintenance Engineer
30	"	Regional Development/Traffic Engineer
31	"	Regional Quantity Surveyor
32	Ashanti	Regional Director
33	"	Regional Maintenance Engineer
34	"	Regional Development/Traffic Engineer
35	"	Regional Quantity Surveyor

Source: DUR, 2014