

**REVIEWING THE APPLICATION OF PERFORMANCE
BASED MAINTENANCE CONTRACTING FOR ROADS
IN NORTHERN PROVINCE**

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“This dissertation was submitted to the Department of Civil Engineering of the University of Moratuwa in partial fulfilment of the requirements for the Master of Science in Construction Project Management”

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Declaration

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Abstract

Road maintenance is essential in order to serve the road for design life, protect adjacent resources and user safety, and provide efficient and convenient travel along the route. Most of the road agencies face the problems of ensuring quality of finish product to serve the design periods and maintain the roads as per the standard. Performance Based Maintenance Contract (PBMC) format is formulated to address these problems.

The objective of this study is to identify the benefits achieved by Road Development Authority (RDA) through implementing the PBMC method, challenges faced by the Authorities when implementing the PBMC method and mitigation measures to overcome the above challenges. The PBMC method was compared with conventional maintenance method and it was found that the roads which are maintained through the PBMC method are in better conditions compared to non PBMC roads, which are directly maintained by RDA through conventional maintenance method. Also, this study revealed that RDA's conventional maintenance method cost is less compared to PBMC method due to restricted budgets and resources allocated to Maintenance Division.

The study further found that PBMC method gives solution for labour shortage and inadequate fund allocation faced by RDA maintenance Division. Also found that PBMC method react quickly to attend the maintenance work due to higher flexibility in the private sector.

In addition to benefits achieved by the RDA, this study identified challenges faced by RDA when implementing the PBMC method. Irresponsible behaviour of the public, the Contractor's reluctance to attend the damages cause by third parties, the Contractors not treat PBM as a part of the main Contract, the Contractors attend the maintenance work just before the RDA inspection, Lack of knowledge and experience about PBMC method among RDA staff, making payment to the Contractors after loan agreement get expired and deficiencies in the Contract Documents were identified as challenges face by Authority when implementing the PBMC methods.

Key words: Performance Based Maintenance Contracts, Road maintenance, Road maintenances methods, Conventional Maintenance.

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LIST OF ABBREVIATIONS

Abbreviation	Description
RDA	Road Development Authority
ADB	Asian Development Bank
PBMC	Performance Based Maintenance Contract
NRCP	Northern Road Connectivity Project
NP	Northern Province
NCP	North Central Province
ADB-AF	Asian Development Bank- Additional Financing
PBC	Performance Based Contracts
WB	World Bank
ROW	Right of Way
IRI	International Roughness Index
NSW	New South Wales
WA	Western Australia
QBS	Quality-Based Selection
MPW	Ministry of Public Works
EE	Executive Engineer
RMTF	Road Maintenance Trust Fund
BOQ	Bill of Quantity

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1 INTRODUCTION

1.1 Background

Road maintenance is essential in order to serve the road for design life, protect adjacent resources and user safety, and provide efficient and convenient travel along the route. Unfortunately, road maintenance is often neglected due to lack of resources, lack of fund allocation, negligence of officer in charge and etc. Postponing road maintenance resulting in rapid deterioration of the road and eventual failure from both climatic and vehicle use impacts.

A Road is designed and constructed to pre-determined standards in order to fulfil a particular function required by road users. Eg. Adequate capacity and safe, economic operational characteristics. As with any type of infrastructure, a road asset will deteriorate over time and will depend on many factors. Maintenance will be essential in order to preserve the asset and ensure the original levels of service are prolonged for as long as possible. (ADB Standard Bid Document, 2009)

Since the assets value of a road network worth billions of rupees, it should be maintain well as per the standard and guidelines issued by the Road Development Authority (RDA). RDA is the premier highway authority in the country responsible for the maintenance and development of the National Highway Network. It network comprised the trunk (A class) and main (B class) road. The planning, design and construction of new highways, bridges and expressways to augment the existing network is a responsible of RDA. Effective maintenance is essential for maximizing benefit of the costly investment in road infrastructure. Effective maintenance reduces the rate of deterioration and prolong the life of the road which delay next major intervention. Lack of drains and drainage maintenance, water stagnation will reduce the life of road significantly.

Most of the road agencies face the problems of ensuring quality of finish product to serve the design periods and maintain the roads as per the standard. Performance Based Maintenance Contract (PBMC) format is formulated to address these problems. PBMC define minimum conditions of road, bridge and traffic assets that have to be met by the Contractor, as well as other services such as collection and management of asset inventory data call-out and attendance to emergencies, response to public requests complaints and feedback. Payments are based on how well the Contractor manages to comply with the performance standards defined in the contract, and not on the amount of works and services executed. (Zietlow, 2004)

RDA has been practising Performance Based Maintenance Contracting (PBMC) from 2009 under Asian Development Bank (ADB) funded Northern Road Connectivity Project (NRCP). Firstly 170km of 6 road sections in Northern Province (NP) and North Central Province (NCP) were selected for Improvement and 3 years Performance based

maintenance. After that through ADB Additional Financing (ADB-AF), 120km of road sections in NP and NCP were selected for Improvement and 5 years performance Based maintenance.

According to Thennakkonwela (2011), the PBM was proofed as a cost effective method for maintenance of Provincial Roads with good road conditions. There is no study conducted in Sri Lankan National Highways to find out the benefits achieved through implementing PBMC method, challenges faced by the authorities when implementing the PBMC method since, this method of contract was adopted only Eight years back. Hence it is a requirement to study the application of Performance-Based Maintenance Contract in Sri Lankan National Highways management.

1.2 Research Problem

The roads which are maintained through the PBMC method look better compared to other roads, which are directly maintained by RDA through conventional maintenance method. Since the PBMC method has been introduced in Sri Lanka in the recent years, the study for the effectiveness of PBMC method has to be done. Therefore, it is required to establish whether existing PBMC method is addressing the problems/drawbacks/gaps in the conventional maintenance method.

1.3 Objectives

The specific objectives of this study are:

- To identify the benefits achieved by RDA through implementing Performance Based Maintenance Contract application in Sri Lankan National Highways management.
- To identify the challenges faced by the Authorities when implementing the PBMC Application.
- To come up with useful mitigation measures to overcome the above challenges.

1.4 Research Methodology

In order to achieve the above objectives, the following research plans were adopted:

- National Highways, which were improved under PBMC method in Northern Road Connectivity Project (NRCP) and National Highways, which are maintained by Maintenance Division Northern Province RDA were used as sample Highways for the study.
- A detail literature review was carried out to investigate Performance Based Contract Application techniques adopted for roads in other countries.
- Interviews and questionnaire survey were used to collect data from the various professionals working in PBMC Application Roads.
- Field visits were carried out to identify the Service Level in PBM method application Roads and Conventional maintenance method application Roads.
- Cost studies were carried out to compare the maintenance cost between PBM method and Conventional maintenance method.

1.5 Main findings

Study compared both Performance based maintenance contract (PBMC) method and conventional maintenance method used by RDA for maintaining the National highways.

It was found that the roads which are maintained through the PBMC method are in better conditions compared to non PBMC roads, which are directly maintained by RDA through conventional maintenance method. Also this study revealed that RDA's conventional maintenance method cost is less compared to PBMC method due to restricted budgets and resources allocated to Maintenance Division.

The study further found that PBMC method gives solution for labour shortage and inadequate fund allocations faced by RDA maintenance Division. Also found that PBMC method react quickly to attend the maintenance work due to higher flexibility in the private sector.

Irresponsible behaviour of public, the Contractor's reluctance to attend the damages cause by third parties, making payment to the Contractors after loan agreement get expired, deficiencies in the Contract documents, lack of knowledge and experience about PBMC method among RDA staff, the Contractor not treat PBM as part of the contract and the Contractors attend the maintenance work just before the RDA inspections were identified as challenges faced by RDA when implementing the PBMC method through this study.

1.6 Scope limitation

This study was limited to National Highways, which were improved and Performance based maintenance carried out under Northern Road Connectivity Project RDA and National Highways, which are maintained by maintenance division Northern Province RDA.

1.7 Arrangement of the report

Chapter 1 of the report provides the background of the study and the problem statement. In addition, the research objectives and the approach to the study are given. Further, the major findings of the research are revealed.

Chapter 2 summarizes and evaluates the research findings on similar areas of study. In addition, it comprehensively reports on the important of road maintenance, different type of road maintenance activity, conventional maintenance method used by RDA and Performance based maintenance contract method.

Chapter 3 illustrates the methodology and data collection of the study in detail and

Chapter 4 analyzes and discusses the data collected.

Chapter 5 concludes the findings of the research referring to the objectives.

2 LITERATURE REVIEW

2.1 Overview

This section will review the existing related literatures regarding Performance Based Maintenance Contracts (PBMC). The purpose of this section is the positioning of the literature in relation to existing knowledge of PBMC for Sri Lankan Highway Management. The main areas of the literature review include the Performance Based Maintenance Contract and its Application in Highway management and its Advantages, Challenges and experience in other countries. The literature review is the knowledge base to continue the research.

Many countries are now heading towards performance-based contracting (PBC), an approach that has been deployed rapidly in the road sector in the past decade. However, while PBC offers a number of benefits for road agencies and road users, it is a relatively new approach and there are several aspects that need careful consideration to ensure that the goals of PBCs are fully achieved.

2.2 Road Maintenance

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

As the asset value of a road network worth billions of rupees it should be managed to avoid deterioration. But not only in Sri Lanka, most of the Asian countries found that this to be a difficult challenge (Liyanage, 2011).

Delaying the road maintenance results in high direct and indirect costs. If the road defects are repaired punctually the cost is usually modest. If the defects are neglected an entire road section may fail totally and requiring full reconstruction with huge cost compared to regular maintenance costs. The South African national Agency Ltd(SANRAL) estimates that repair costs rise to six times maintenance costs after 3 years maintenance neglected and to 18 times after 5 years maintenance neglected(SANRAL, 2004).

Maintenance costs are generally small compared to other direct costs of road travel (World Bank, 1994).

As per Tamin R, Tamin A and Marzuki (2011), Low quality construction work, overloading of vehicle, irregular maintenance due to limited fund and resources and weak coordination among authorized institutions are main reasons behind the road failure.

Delayed maintenance has indirect cost also. Maintenance neglected roads gradually became more difficult to use, resulting in increased vehicle operating costs (more frequent repairs and more fuel usage) and unwillingness by transport operators to use the roads. This imposes a heavy burden on the economy. There is a consequent loss of economic and social development opportunities. (ILO, 2007)

Poorly maintained roads effects the mobility and considerably raise the vehicle operating costs, increase accident rates and their associated human and property costs and worsen the isolation, poverty and poor health in rural communities.

According to the Road Maintenance Manual RDA (1989, 6-8), There are four main types of road maintenance are carried out by RDA. They are,

- Routine maintenance
- Recurrent Maintenance
- Periodic Maintenance
- Urgent Maintenance

2.2.1 Routine maintenance

These activities are required for the general preservation of the road network irrespective of road characteristics and the traffic that they carry.

They include:

- The general upkeep of the shoulders and the road side including cutting grass, weeding, vegetation control, filling scoured areas and planting grass.
- Clearing and recutting of drains.
- Cutting scupper drains and building scour controls.
- Clearing and desilting of culverts.
- Clearing of channels, gullies, manholes and storm water pipe drains.
- Cleaning and painting of bridges and other structures.
- Cleaning and painting of road furniture.

(Road Maintenance manual RDA 1989, 6-8)

2.2.2 Recurrent Maintenance

These activities may be required at intervals throughout the year depending on the damaging effects of traffic, rain etc. They include:

For Paved roads: -

- Repairing potholes, ruts, depressions, cracks and surface irregularities
- Corrections to the edges of pavements and shoulder edges.

For Unpaved roads: -

- Repairing potholes, ruts, depressions and erosion gullies.
Dragging, brushing and lightly grading to remove unevenness's and easily removable corrugations. (Road Maintenance manual RDA 1989, 6-8)

2.2.3 Periodic Maintenance

These activities are required at periods of several years, the frequency depending on the damage caused by traffic and other factors as well as the standard of maintenance. They include:

For Paved roads: -

- Base and surface corrections, surface applications, surface dressings and constructing surfacing.
- Grading and re-gravelling of shoulders.

For Unpaved roads: -

- Grading and re-gravelling.

Bridges: -Re-decking. (Road Maintenance manual RDA 1989, 6-8)

2.2.4 Urgent Maintenance

Urgent maintenance covers the items to be carried out without delay to avoid danger to the traffic.

They include: Restoration of flood damage slides etc. Road diversions. Removal of fallen trees and branches. (Road Maintenance manual RDA 1989, 6-8)

2.3 Economic and social impacts due to lack of maintenance

Lack of maintenance affects the economy of the country in several ways. RDA roads are normally connecting the Provincial capitals, Cities and Villages which facilitates marketing, schooling and health services. Better access provides the opportunity for employment, marketing for products and increase the income also contribute to reduction of poverty (ILO, 2007).

According to the International Labor Organization (2007), Overall impacts to economy of the country due to lack of maintenance could be indicated as follows.

- Vehicles owners (increased vehicle operating costs, and rapid depreciation of vehicles).
- Passengers (Increased travel times, high fares, lower frequency, less comfort)
- Farmers, Entrepreneurs and Traders (higher transport costs for inputs and raw materials and higher prices of hauling produce to markets)
- Governments (additional expenditures in terms of rehabilitation costs).

Providing maintenance on right time may cause to make a considerable saving on capital expenditure for new constructions and rehabilitation of roads. Rehabilitation or improvement works requires huge money compared to maintenance cost. Generally Rehabilitation and improvement works for RDA Roads are done through foreign funded project since the government of Sri Lanka does not have such huge money to do the works.

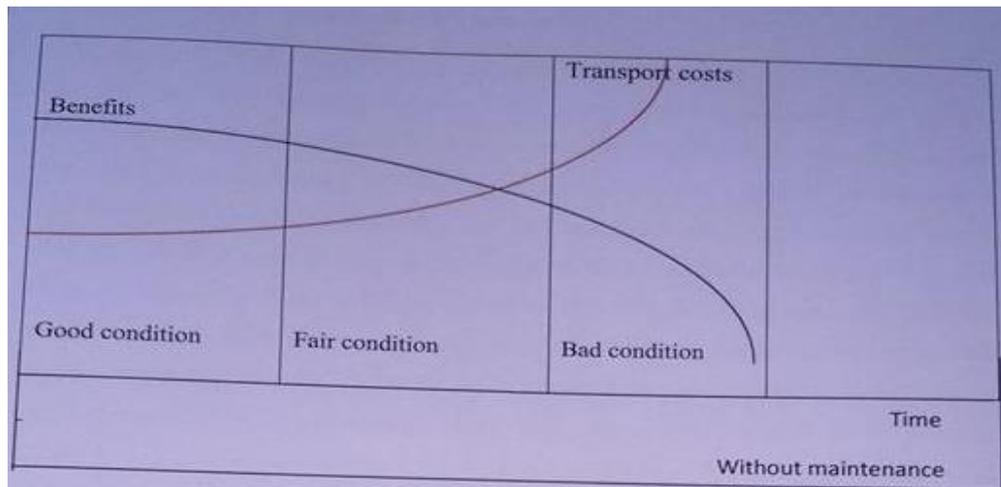


Figure 2.1 Road Investment- Socio Economic benefits

Source: International Labour Organization, 2007

2.4 Performance Based Maintenance Contract (PBMC)

Performance Based Maintenance Contracts (PBMC) significantly differ from the method-based contracts that have been traditionally used to maintain roads. In traditional method-based contracts, the road agency specifies techniques, technologies, materials and quantities of materials to be used, together with the time period during which the maintenance works should be executed. The payment will be made to the contractor is based on quantity of works completed and measured. There are unit rates for work items e.g., cubic meters of Sub Base, number of working hours (Transport Note No 27 WB, 2009).

According to Zietlow (2004), PBMC define minimum conditions of road, bridge and traffic assets that have to be met by the Contractor, as well as other services such as collection and management of asset inventory data call-out and attendance to emergencies and response to public requests complaints and feedback. Payments are based on how well the Contractor manages to comply with the performance standards defined in the contract, and not on the amount of works and services executed.

In PBC, the Employer/Road Agencies does not specify any method or material requirements. Instead he specifies performance indicators that the contractor is required to meet when delivering maintenance services. Performance specifications are called as "levels of service" in some countries. Within the road sector, PBC can be "pure PBC" or "hybrid PBC". The Hybrid combines feature of both method based and performance-based contracts. Some services are paid on a unit rate basis, while others are linked to meeting performance indicators (Transport Note No 27 WB, 2009).

The concept of PBM Contract is originated from a consideration of the increasing lack of personal within the government road agencies available to measure the vast quantities of activities involved in the traditional maintenance contract and to monitor performance standards using inputs indicators, the frequency of claims resulting from the necessity to increase the quantities of activities of the original contract, the need to focus more on customer satisfaction and the need to shift greater responsibility to contractors the entire Contract period (Transport Note No 27 WB, 2009).

A PBC shall cover either only individual assets (e.g., only traffic signs, only bridges) or all road assets within the Right of Way (ROW) within a road corridor. 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). A "comprehensive" PBC would typically cover all road assets within the ROW 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 30 years (Transport Note No 27 WB, 2009).

2.4.1 History of Performance based Contracts

The development of Performance based Contracts for road maintenance started in the late 1980's and early 1990's. First **British Columbia in Canada** contracted out its road maintenance in 1988. But performance standards were still more oriented, very much limiting the contractor in the application of new technologies.

After that, **Argentina** started nearly 1000km of its national roads, using end result performance specification for the maintenance services and a penalty system was introduced for the Contractor who does not meet the specification. In 1990 the maintenance of another 10000km was contracted out using similar performance specifications.

Uruguay started its pilot study for performance contracts on a small network of 359km of its national roads in 1990. Performance contracts systems proved to be so successful that now, only five years later, 50% of the national roads in Uruguay are being maintained through Performance Contract method.

Latin American countries such as **Brazil, Chile and Colombia** have started similar contracts. Most of these contracts include partial rehabilitation to bring roads to maintainable conditions. Today, in Latin America more than 40000km of roads are being maintained under Performance Contracts.

Australia started its first Performance Contracts in 1995 covering 459 km of urban roads in Sydney. Since then several new contracts have been implemented in New South Wales, Tasmania and Southern and Western Australia. Some of them as so called hybrid contracts, where some of the works are being paid based on quantities and unit rates.

New Zealand started its first Performance Contract for the maintenance of 406km of its national roads. At present 15% of New Zealand's national roads are maintained through the new contract method.

In the **United States of America**, the state of Virginia pioneered a Performance Contract called “Asset Management and Maintenance Contract” for the maintenance of 402km of interstate Highways in 1996. After 4 years Washington D.C. followed suit with a similar contract that covers 119km of federal roads. Both of the above said contracts are considered as pilots (Zietlow, 2004).

According to Zietlow (2004), performance based contracts have spread to European, African and Asian countries and These efforts are strongly supported by international donors like World Bank, the European Bank for Reconstruction and Development and the Asian Development Bank. Table 2.1 shows that Asian and other countries which are implementing the PBC.

Table 2.1 Countries which implementing the PBC (Transport Note No 27 WB 2009)

No	Asian Countries	From	Other Countries	From
01	India	2009	Canada	1988
02	Nepal	2003	Australia	1995
03	Sri Lanka	2009	New Zealand	1998
04	Malaysia	2000	Finland, USA	1996
05	Vietnam	2009	Latin America, Argentina	1995
06	Afghanistan	2006	Uruguay,	1990
07	Tajikistan	2010	Guatemala, Mexico, UK	2001
08	Indonesia	2010	Sweden, Finland	1998
09			Zambia	2001
10			Brazil, Chile, Peru	1994-1998

2.4.2 Reasons for Implementing Performance based maintenance Contracts

According to Zietlow (2004), there are several reasons for implementing Performance based maintenance Contract. They are

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

2.4.3 Benefits achieved by Road agencies through Implementing PBMC for Roads

As per Transport Note No.TN-27 World Bank, 2005 (updated 2009), Road agencies that have adopted a PBMC approach, have achieved following benefits through implementing PBMC.

(a) Cost savings from 10% up to 40% in managing and maintaining road. Table 2.2 shows that Countries which have achieved cost savings through implementing the PBMC method compared to conventional maintenance method.

Table 2.2 Countries which have achieved cost savings through implementing the PBMC method compared to conventional maintenance method. (Pakkala, 2005)

Country	Cost savings, %
Norway	About 20-40%
Sweden	About 30%
Finland	About 30-35%; about 50% less cost/km
Holland	About 30-40%
Estonia	20-40%
England	10% minimum
Australia	10-40%
New Zealand	About 20-30%
USA	10-15%
Ontario, Canada	About 10%

(b) Expenditure certainty for road agencies

The PBC helps to insure that variation orders are minimized and that the contractor is generally paid in equal monthly installments throughout the contract period. The risk for cost overruns is transferred to the contractor and the road agency faces fewer unpredictable costs such as emergency work.

(c) Reduction of the in-house workforce

In the PBC approach, fewer contracts have to be processed and administered, and there is no need to measure vast quantities of inputs as a basis for payments. Due to the reduced administrative effort needed, the road agency can manage its network with fewer in-house personnel. According to ENRA (2004), in Estonia the work force of the national road agencies has declined to 692 employees in 2003 from 2046 employees in 1999.

(d) Road user satisfaction with road service and condition

The PBC can deliver higher customer satisfaction by aligning contractor payments with the needs of the customer/road users. These needs are directly reflected in the performance indicators specified in the contract. Performance specifications set a minimum level of service that is expected from the contractor over the entire contract period. For example, No Potholes. According to Zietlow (2004), in Chad road users appreciate that always the road is in good condition. Especially important is that they can use the road in the rainy season, which was impossible before.

(e) Stable multi-year financing for maintenance program.

A PBC approach can help ensure stable financing for the maintenance program over a longer-term when compared with traditional method-based contracts. A PBC typically covers a period of several years. It therefore obliges the government to make a multi-year funding commitment for road maintenance. According to Liautaud (2004), Argentina has deterred the treasury from failing to provide funding for road maintenance.

2.4.4 Performance Indicators and Response time for PBMC

According to Zietlow (2004), defining the Performance indicators is a challenging task since it has to satisfy the set of goals such as:

- Minimize the total cost, including the long- term cost of preserving road, bridge and traffic assets and the cost of the road user

- Satisfy comfort and safety of road users

In addition, the Performance indicators have to be clearly defined and objectively measurable.

Typical performance indicators are:

- The International Roughness Index (IRI) to measure the roughness of the road surface.
- The absence of potholes and control of cracks and rutting.
- The maximum amount of siltation or other obstruction in the drainage system.
- The reflectivity of the road signs and marking for the safety of the road user.

Table 2.3 Examples of Performance indicators Applied in Different Performance contracts in Latin America. (Zietlow 2004)

Assest Class	Component	Performance Indicator
Pavement	Potholes	No Potholes
	Roughness (Asphalt)	IRI<2.0 (Argentina, IRI<2.8 (Uruguay)
	Roughness (bituminous)	IRI<2.9 (Argentina, IRI<3.4 (Uruguay)
	Rutting	<12mm(Argentina) <10mm (Uruguay)
	Cracks	Sealed
Gravel Surfaces	Potholes	No Potholes
	Roughness	IRI<6.0 (Uruguay, IRI<11.0 (Chile)
	Thickness of gravel layer	10cmm (Chile, Uruguay)
Shoulders	Potholes	No Potholes
	Cracks	Sealed
	Joints with pavement	Vertical alignment <1cm (Chile, Uruguay), sealed (Peru)
Drainage system	obstructions	No obstructions. Should allow for free flow of water(Chile, Uruguay)
	Structures	Without damages and deformations (Chile, Peru)
Road signs and markings	Road signs	Complete and clean (Argentina, Chile, Peru)
	Road markings	Complete and visible (Argentina,Chile,Peru)
	Reflectivity of road markings	160mcd/lx/sqm (Argentina) 70 mcd/Lx/sqm (Uruguay)
ROW	Vegetation	< 15cm height (Argentina, Uruguay)
	Foreign elements	No foreign elements allowed.

Table 2.3 shows that Performance indicators applied in different performance contracts in Latin America. In Sri Lanka RDA also used performance indicators which were modified for Sri Lankan conditions, to measure the performance standard of the Contractor throughout the Performance based maintenance period. Payments for the Contractors are made based on how well the Contractors manage to comply with the performance standard.

Each performance indicator has a response time and there is a penalty for non-compliance. According to Zietlow (2004) In Argentina, for each pothole more than 2 cm deep, a penalty of US\$ 100 is being applied for each day it stays open. Performance indicators and response times are varying from one contract to another. Each country seems to follow a slightly different path due to a variety of factors. Table 2.4 shows that Contract Standards and response times used in the State Highway Maintenance Contract Proforma Manual SM032 of Transit New Zealand.

Table2.4 Example of Contract Standards and response times used in the State Highway Maintenance Contract Proforma Manual SM032 of Transit New Zealand. (Zietlow, 2004)

Feature	Contract Standard	Response Time
Potholes on highways with >10000 vpd	Not more than 3 potholes with a diameter greater than 70mm on any 10km section.	48 hours
Potholes on all highways	No potholes greater than 150mm in diameter	48 hours
Depressions and Rutting	No ponding greater than 30mm in depth at any location	6 months
Edge Break	No more than 2m of edge break within any continuous km greater than 0.5m	1 month
Lined Channels	No lined channels with more than 10% of the cross-sectional area obstructed, and free of vegetation.	1 week

As per the Northern Road Connectivity Project Contract documents (2011), RDA has defined the Performance Indicators and for each performance indicators there is a response time. In every monthly inspection to Performance based maintenance contract roads, respective Executive Engineer RDA who is the Engineer for the Contract has checked weather the Contractor is maintaining the roads as per the Contract. A penalty will be applied for the non-compliance.

2.4.5 Main challenges faced by Road agencies when Implementing PBC for Roads

As per Transport Note No.TN-27 World Bank, 2005 (updated 2009), road agencies faced following main challenges when introducing and expanding PBC

- Adequate allocation of risks to the party that is able to manage them best
- 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.
- Need to acquire a new set of skills and expertise to enable the road agency staff to effectively develop and manage a PBC program.
- Downsizing of the road agencies. Extensive adoption of the PBC approach may trigger the need to reduce the in-house work force, since significantly less effort is needed to administer and supervise PBCs.
- Choosing a PBC format that is consistent with the contracting industry capacity available in the country.

2.5 Road maintenance in Sri Lanka

According to Thennakoonwela (2011), Road network in Sri Lanka is mainly classified in to national roads, provincial roads and Local authority roads according to their management responsibility.

The Sri Lankan road network consist of

- | | |
|---|------------|
| • Road Development Authority | 12379.49km |
| • Provincial Council | 16000.00km |
| • Municipal Council, Urban council | 5176.00km |
| • Pradesiya Saba and other organization | 97916.00km |

2.5.1 Road Development Authority Sri Lanka

The Road Development Authority (RDA) is the premier highway authority in the country and is responsible for the maintenance and development of the National Highway Network, comprising the Trunk (A Class) and Main (B Class) roads and the planning, design and construction of new highways, bridges and expressways to augment the existing network. The RDA is a major Civil Engineering Organization with specialized skills in Highway and Bridge Planning, Design, Construction, Maintenance and Highway Safety. The RDA organization under the Board of management has the Director General as the Chief Executive Officer. The Director General is assisted by 5 Additional Director Generals and 17 Directors to carry out various functions. There are 17 functional divisions in RDA each headed by a Director. The Directors in charge for Mechanical division, Legal Division & Expressway Operation & Management division operate directly under the Director General. The rest of 14 functional divisions are managed by 4 Additional Director Generals. Foreign funded projects in RDA are managed by Project Management Units. Each project management unit is headed by a Project Director and they operate under the Additional Director General for Projects. The RDA has a workforce of 4,562 employees on permanent and contract basis comprising of engineering, technical, administrative, accounting and other support staff. In addition it has 4,024 permanent and 2,428 contract basis labourers employed for routine maintenance work. Table 2.5 shows that National Highways own by RDA. (www.rda.lk, 2016)

Table 2.5 National Highways own by RDA. (Road List RDA, 2009)

In Sri Lanka			In Northern Province Sri Lanka	
	Road Class	Length	Road Class	Length
01	A Class Road	4217.42 km	A Class Road	734.49 km
02	B Class Road	7992.94 km	B Class Road	524.97 km
03	E Class Road	169.13 km	E Class Road	0
	Total	12379.49 km	Total	1259.46 km

2.5.2 Road Maintenance methods practiced by RDA

There are two types of maintenance methods are practiced by RDA, Conventional maintenance methods and Performance based maintenance method. Most of the RDA roads are maintain through conventional maintenance methods where RDA used their own resources such as material, labor and machinery or sometimes RDA use private contractor to maintain the roads. Currently some of the RDA roads are maintain through the PBM method in experimental level.

As per Northern Road Connectivity Project (NRCP) contract documents (2009), in PBM method, the Contractor shall undertake to carry out maintenance of the roads for a continuous period depending on the contract, from the date of issue of the Taking over certificate for which the Contractor shall be paid separately as a monthly payment depending on performance indicator he has achieved during the particular month.

Table 2.6 Comparisons of Conventional Maintenance method and PBM method.

No	Conventional Maintenance method.	PBM method
01	Continues supervision is required to ensure the quality of work.	Continues supervision is not required since the Contractor is bound by the contract to up keep the road standards as agreed in the Contract.
02	High Risk for the Road Agency	the Contractor carries greater risk and responsibilities
03	Measurements of vast quantities of activities are required	Payment is made on a fixed price lump sum basis normally through uniform installments, linked to continuing to meet performance targets
04	Contract period is less	The duration is typically longer than the Conventional contracts
05	Possible revision of contract Price	No change in the Contract value till the Contract is completed
06	Difficult to keep track of measure the quantities of materials ,equipment's and labour, tons of pot holes patch material used ,number of linear meters of pipe culvert replaced, number of square meter of cracks sealed etc.	Agreed intervention level of up- keep avoids the measuring of quantities as payments are made based on standard of up-keep and deduction imposed from payment up on failure.

Table 2.6 shows the comparison of conventional maintenance method and PBM method. It clearly shows that continuous supervision is not required for PBM method and the PBM Contractor carries greater risk and responsibility. Conventional maintenance method requires measuring of vast quantities of activities but in the PBM method no need such measurements since payments are based on fixed price. Only thing is the Employer should check whether the Contractor has achieved the performance indicators which were agreed in the contract.

2.5.3 Conventional maintenance method practiced by RDA

According to the Road Maintenance Manual RDA (1989, 6-8), all road maintenance work is the Executive Engineer (EE), who is the key person responsible for the planning, programming, organizing and carrying out of all operations regarding the associated activities of road maintenance. In RDA, all road maintenance work, in general, will be carried out through maintenance contractor or through direct labour of the organizations. The Engineers approach to the planning, programming and organizing of work will necessarily differ in the two cases. Where work is carried out through maintenance contractors the Engineer has to be very specific in his method of instructing and work allocation and in direct labour organizations the Engineer will necessarily have to arrange for more stringent supervision by his own staff. Road maintenance Division Northern Province RDA carry out the maintenance work through direct labour of the organization only. Material required for road maintenance works will be supplied by various suppliers who registered under RDA. RDA uses their own machinery or sometimes use hired machinery for road maintenance activity.

The funds for periodic and routine maintenance for the RDA roads are implemented through the Road Maintenance Trust Fund (RMTF) established in late 2005 with ADB assistance. Based on a schedule prepared by assessing the network condition, RDA releases a predefined allocation for each divisional office after assessing of the value of maintenance requirement (Thennakoonwela, 2011). Table 2.7 shows that fund allocation for road maintenance for Northern Province RDA for year 2016 through the Road Maintenance Trust Fund (RMTF).

Table 2.7 Fund allocation for Road maintenance for Northern Province RDA for year 2016 (Works Programme of RMTF- 2016)

No	Description	Allocation (Mn) Rs
01	Routine Maintenance	60.00
02	Periodic Maintenance	134.50
03	Structure Improvements	18.93
04	Maintenance of Signal Lights, Lights, Road Marking & Installation of Road Furniture	14.39
05	Emergency Maintenance/Dissaster Works	10.20
06	Maintenance of Ferries	13.00
	Total	251.02

As per Thennakoonwela (2011), Sri Lanka has no overall pricing on transport. Varieties of user charges are applied and include:

- Duties of imported vehicle
- Annual registration fees
- Import duties on spare parts and tires
- Taxes on gasoline, diesel and lubricants

2.5.4 Road maintenance issues in RDA

Normally roads are design for a 10 to 15 years life period. The pavement and width of the roads are based on the anticipated traffic over the period of life time. After completion of design life it is required to re-plan the road (Connors &Kumarage, 2011). In Sri Lanka, after the completion of design life Rehabilitation or Improvement works are carried out by the RDA in order to improve the Service Levels of the Roads. Since Sri Lanka is a developing country it does not have enough money to do the rehabilitation or improvement on time. The inability to rehabilitate the roads on time means that its maintenance task become difficult with time period between successive cycles of repair decreasing as the road condition deteriorates at an increasing rate.(Connors &Kumarage, 2011) therefore road maintenance cost are increased with time but RDA does not have enough money to do the big maintenance. Therefore most of the roads which are directly maintenance by RDA are in unsatisfactory condition due to lack of maintenance.

Since the asset value of a road network worth billions of rupees, it should be maintain well in order to minimize the deterioration. But not only in Sri Lanka, most of the Asian countries found this to be difficult challenge (Liyanage, 2011).

According to Thennakoonwela (2011), there are number of reasons behind these difficulties. They are

1. Insufficient funds allocated for road maintenance
This is because of the weak economic situation in many countries, but compounded because available funds are often diverted to politically visible capital projects, or utilized poorly, sometimes to support large unproductive labour forces.
2. Shortage of qualified staff or skilled labour
Since there is a lack of qualified staff and lack of skill labour in Northern province RDA this may cause to poor quality of road maintenance work. Though Executive Engineer and technical officers are responsible for maintenance works, very often maintenance works are supervised by an unqualified in charge. As a result poor quality of maintenance work can be obtained.
3. Shortage of machineries
This is partly related to lack of funds, but also to poor equipment management practices and bureaucratic procedures for procurement of both new equipment and spare parts.
4. Poor institutional arrangements and management capability
Many of the road administrators are poorly focused with too many responsibilities; emphasis is often put on works execution, while management is often neglected.

5. Paying less attention about the road drainage by responsible officers

It was observed that the responsible officer for road maintenance sections pay less attention to road drainage or neglect the drainage issues in maintaining the roads. Therefore people always use the road shoulders for their private purposes such as to stack the timber, plant trees etc. In Sri Lanka, residents living along the both side of the roads put their garbage into the side drains. Therefore storm water can't drain out properly and it may cause to damage the roads.

2.5.5 Performance Based Maintenance Contract in RDA

RDA has been practising Performance Based Maintenance Contracting (PBMC) method from 2009 under Asian Development Bank (ADB) funded Northern Road Connectivity Project (NRCP). Firstly 170km of 6 road section in North Province (NP) and North Central Province (NCP) were selected for Improvement and 3 years Performance based maintenance. After that through ADB Additional loan, 120km of road sections in NP and NCP were selected for Improvement and 5 years performance Based maintenance.

2.5.5.1 Selection of Contractors for PBMC in RDA

According to the NRCP Bid documents (2009), Single Stage Two- Envelop method was used to select the Contractors for NRCP. In the Single- stage two Envelop bidding procedure, Bidders submit two sealed envelopes simultaneously, one containing the Technical Proposal and the other the Price Proposal, enclosed together in an outer single envelope. Initially, only the Technical proposals are opened at the date and time advised in the Bidding Document. The Price proposals remain sealed and are held in custody by the Employer. The Technical Proposals are evaluated by the Employer. Bids of the Bidders who do not conform to the specified requirements are rejected as deficient Bids. Then the Price Proposals are opened in public. The Price Proposals are evaluated and the Contract was awarded to the Bidders whose Bid has been determined to be the lowest evaluated substantially responsive Bid.

As per Transport Note No.TN-27 World Bank, 2005 (updated 2009), 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.

Table 2.8 Evaluation criteria and their weight that were applied during the evaluation of bids in Washington, D.C., USA, 2000 (Zietlow, 2004)

Criterion	Description	Weight
Technical	Experience, knowledge and understanding of issues relating to preservation and 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 preservation, maintenance, and management contracts demonstrates a likelihood of successfully performing all of the tasks set forth in this Invitation for Bids.	15%
Cost	The extent to which proposed costs are realistic and reflect the likely overall cost to the government over the term of the contract.	50%

Table 2.8 shows that Evaluation criteria and their weight that were applied during the evaluation of bids in Washington, D.C, USA in 2000. It is clearly shows that when evaluating the bids there is 50% of points given to the Bidders based on Technical, Staffing, Quality Control/Quality Assurance, Management and Past Performance. Only 50% of points given based on cost. But in Sri Lankan NRCP projects after evaluating the Technical Proposal The Price Proposals are evaluated and the Contract was awarded to the Bidders whose Bid has been determined to be the lowest evaluated substantially responsive Bid. There is no points given for the Contractor technical capability.

2.5.5.2 PBM Contract Duration in RDA

Performance Based Maintenance period for NRCP is 3years and NRCP-AF is 5 years. But According to Transport Note No 27 WB (2009), Performance based maintenance contract tenure is usually from 3 years to 10 years and could go up to 30 years. Most of the other countries extended their contract period up to 3 to 10 years. The duration of the contract should be sufficient to achieve the full benefit of the PBMC.

2.6 Summary

Road maintenance is essential in order to serve the road for design life, protect adjacent resources and user safety and provide efficient convenient travel along the road.

Delaying the road maintenance results in high direct and indirect costs. If the road defects are repaired punctually the cost is usually modest. If the defects are neglected an entire road section may fail totally and requiring full reconstruction with huge cost compared to maintenance cost.

Performance Based Maintenance Contract (PBMC) format is formulated to address these problems. PBMC method define minimum conditions of road, bridge and traffic assets that have to be met by the Contractor. Payments are based on how well the contractor manage to comply with performance standard define in the contract and not on the amount of works and services executed.

PBMC projects are very successfully implemented in most of the countries. RDA has been practising PBMC from 2009, under Asian Development Bank (ADB) funded Northern Road Connectivity Project (NRCP).

3 METHODOLOGY OF STUDY AND DATA COLLECTION

3.1 Introduction

A systematic method should be followed to find out the answers to research questions and to achieve the research objectives. This approach is called as research methodology and it is discussed in this chapter.

3.1.1 Research process and research design

Research process indicates the total process that is involved initiating, conducting and completion of the research in an organized and logical order. Identification of the research questions and formulation of research objectives with the selected research method will be guiding to achieve the defined outcome of the research while fulfilling aims and objectives of the research. This in effect forms research design has a part of the research process. The figure 3.1 shows that the research design applicable to the current research.

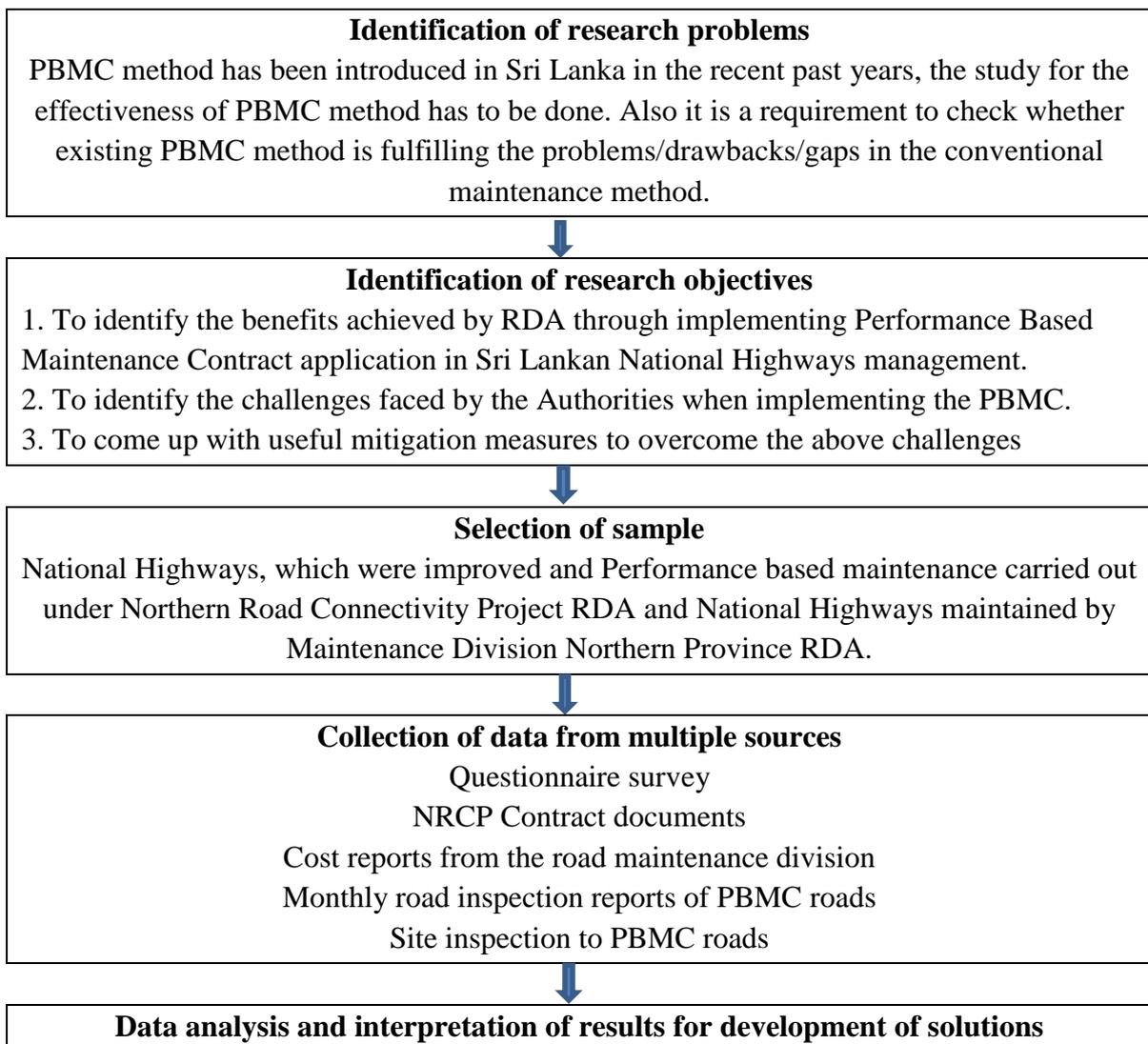


Figure 3.1 Research design

3.2 Data Collection

Qualitative and quantitative information was utilized in the research concurrently. Whereas qualitative information was required to evaluate the benefits achieved by RDA through implementing the PBMC and challenges faced by the authorities when implementing the PBMC, quantitative information was required to compare the cost incurred to RDA for Conventional maintenance method and Performance based maintenance.

The data collections were done in the following forms

- A questionnaire survey and Interview with RDA engineers who has involved with Performance Based Maintenance and Conventional Maintenance for Northern Province RDA Roads.
- Northern Road Connectivity Project Contract documents.
- Conventional maintenance cost reports from Northern Province Road Maintenance Division RDA.
- Monthly formal inspection records which are jointly prepared by Employer and Contractor for Performance based maintenance Roads.
- Site inspection to Performance based maintenance roads and Conventional maintenance roads.

3.2.1 Questionnaire survey

In July 2017, a questionnaire survey was carried out among RDA engineers who are working in Project Management Unit, Northern Road Connectivity Project and Northern Province road maintenance division RDA to get their ideas and experiences about Performance based maintenance and Conventional maintenance. Project Director, Senior Project Engineers, Project Engineers and a Resident Engineer participated to this survey from Project Management Unit, Northern Road Connectivity Project. They have experience in Performance based maintenance and in Conventional maintenance. Also, they had involved in preparation of bid documents and specification for Performance based maintenance contract, evaluation of bids and selection of successful bidder and they have involved in implementation of Performance based maintenance contract method from the beginning. They had vast experience and knowledge in application of performance-based maintenance contract for National Highways in Sri Lanka. They gave valuable contribution for this research.

From the Northern Province road maintenance division RDA, Provincial Director Northern Province, Chief Engineers (Jaffna/Kilinochchi/Vavuniya), Executive Engineers (Jaffna, Pointpetro, Kilinochchi, Mullaitivu, Vavuniya, Mannar) and Engineers who are working in Provincial Director's Office, Chief Engineer's Office also participated in this survey. Most of them have experience and knowledge about both maintenance methods and some of them have conventional maintenance experience only.

There are 27 questionnaires were directly distributed among Engineers who are working in Project Management Unit, Northern Road Connectivity Project and Road maintenance division Northern province RDA and 20 Engineers were responded to questionnaire survey.

3.2.2 NRCP Contract Documents

The Contract documents of Northern Road Connectivity Projects were collected from the Project Management Unit RDA. The terms and conditions of the contract specially specification for Performance based maintenance, were extracted from the contract documents for analysis. From 2009, there are 19 contracts were awarded to the Contractor by RDA for Performance based maintenance in Northern and North central Province under Northern Road Connectivity Project. Table 3.1 shows that PBMC methods applying roads in Northern and North central Provinces. Performance based maintenance cost for roads were extracted from the contract BOQ to compare with Conventional maintenance cost.

Table 3.1 PBMC methods Applying Roads in NP& NCP under NRCP (Project Management Unit NRCP-RDA, 2016)

No	Contract No	Name of the road/Bridge /Project Activitiy	Length (km)	PBM
1	CP-1	Dambulla to Thonigala (A009) (74+650-98+000km)	23.35	3 years
2	CP-2	Thonagala to Galkulama (A009) (98+000 - 122+170km)	24.17	3 years
3	CP-3	Anuradhapura to Rambewa(A020)(0+000-14+500km)	14.50	3 years
4	CP-4	Nawvathkuli to Kerativu(A032) (0+000-17+400km)	17.4	3 years
5	CP-5	Manipay to Kaithady(B268) (0+000-14+020mk)	14.02	3 years
6	CP-6	vallai to Araly road (0+000-27+400km)	27.40	3 years
7	CP-7	MankulamMullativu Road A034 0+000 km to 13+000km	13.00	3 years
8	CP-8	MankulamMullativu A034 road 13+000 km to 24+000km	11.00	3 years
9	CP-9	MankulamMullativu Road A03424+000 km to 38+500 km	14.50	3 years
10	CP-10	MankulamMullativu Road A034 38+500 to 49+100km	10.60	3 years
11	CP-11	Vavuniya - Horowupathana Road A02924+000km to 34+950	10.95	5 years
12	CP-12	Medawachchiya - Kebithigollewa Road B283 0+000km to 12+600	12.6	5 years
13	CP-13	Medawachchiya - Kebithigollewa Road B283 12+600 to 25+400	12.8	5 years
14	CP-14	kebithigollewa - PadaviyaRoad B211(0+000km to 15+500)	15.5	5 years
15	CP-15	kebithigollewa - Padaviya Road B211(15+500km to 31+345)	15.85	5 years
16	CP-16	Medawachchiya - Mannar Road A014(47+000 to 62+100)	15.1	5 years
17	CP-17	Medawachchiya - Mannar Road A014 from 62+100km to 76+600	14.5	5 years
18	CP-18	Jaffna - Pannai - Kayts Road AB019 from 0+000 to 10+000km	10	5 years
19	CP-19	Jaffna - Pannai - Kayts Road AB019 from 10+000km to 20+270km	10.27	5 years

3.2.3 Cost reports from the Road Maintenance Division

The cost incurred to RDA for Conventional maintenance method and Performance based maintenance method were compared in this study. Performance based maintenance costs per kilometre per month were directly extracted from the Contract Bill of Quantities. It was found that collection of Conventional maintenance cost for Northern Province RDA roads was very difficult task due to poor record keeping practices in RDA. Yearly maintenance cost reports for Conventional maintenance works from 2011 to 2016 for every Executive Engineer divisions in Northern Province were collected from the Provincial Director's office, RDA for analysis and from that records average conventional maintenance cost per km per month was calculated. Road wise cost records for routine and recurrent maintenance works for Conventional maintenance method applying roads which were rehabilitated in 2012 to 2014 period with PBM applications roads, were collected for analysis within Executive Engineer's Division Jaffna and from that records conventional maintenance cost per km per month was calculated.

3.2.4 Monthly road inspection reports of PBM method applying Roads

Every month RDA staffs and the Contractor's representatives are jointly inspecting the PBM method applying roads to check whether the Contractor achieving the performance indicator as per the contract. Based on the inspection Executive Engineers RDA are preparing reports for making monthly payment to the contractor. Monthly inspection reports for July 2017 for Jaffna – Pannai –Kayts road (AB 019), were randomly collected from RDA for analysis.

3.2.5 Site inspection to PBM method applying roads and Conventional maintenance method applying roads.

Personal site inspections for PBM method applying roads and Conventional maintenance method applying roads in Northern Province, were carried out in month of July 2017. Jaffna-Pannai- Kayts Road (AB 019) and Mathawachchiya Mannar road (A014) were randomly selected for inspection for PBM method applying roads and photos were taken at every 500 m interval. Vallai- Thellippali- Araly road (B437) was randomly selected for inspection for Conventional maintenance method applying road and photos were taken at every 500m interval.

Both PBM method applying roads and Conventional maintenance method applying roads are similar in traffic and climatic conditions and also both roads are rehabilitated with Asphalt pavement in 2013- 2014 period.

In addition to above site inspections, 2km section of Vallai- Thellippalai-Araly road (B437) was inspected deeply by walk along the road in August 2017 with the help of Technical Officer who involving in PBM roads inspection. Same format of reports which are used to evaluate the condition of roads for PBM method applying roads, were prepared for ease of comparisons.

3.3 Data analysis methodology

With respect to the data collection, the analysis was done to find out the benefits achieved by RDA through implementing the PBMC method and challenges faced by the authority when implementing the PBMC.

For the ease of comparison cost and quality data were tabulated and answers from the questionnaires were put into charts.

3.4 Limitations to the research

It was found that the data collection was the very difficult task in the research, because of the poor record keeping practices within the RDA and there was no clear idea about the PBMC method within engineers who are working in RDA maintenance division since this is a new concept to the RDA.

When collecting the Conventional maintenance cost for roads, it was found that collecting road wise cost records were very difficult task due to poor record keeping practices in RDA. Therefore road wise cost records were collected in Executive Engineer's Division Jaffna for limited no of roads for year 2018 only. Yearly Conventional maintenance cost records for every Executive Engineer's division in Northern Province, were collected and from that records average Conventional maintenance cost per km per month was calculated for analysis.

Engineers who has knowledge about PBM method and involving with PBM Projects are very less within the RDA. Therefore questionnaire survey was carried out within the limited no of engineers in July 2017. Only 27 engineers participated in questionnaire survey from Northern Province Road Maintenance Division RDA and Northern Road Connectivity Project Division RDA. Out of 27 engineers only 20 engineers responded to questionnaire survey.

3.5 Summary

Data was collected from the Project Management Unit NRCP and Northern Province Road Maintenance Division RDA, focusing on benefits achieved by RDA through implementing PBMC method and challenges faced by the authorities when implementing the PBMC method.

The questionnaire survey was conducted among the engineers, who was working in Project Management Unit NRCP RDA and Road Maintenance Division Northern Province RDA.

Personal interviews with the senior staff were carried out as they are reluctant to fill questionnaire with their busy schedules.

Lack of documentations and lack of data bases regarding projects both in the Project Management Unit and Maintenance Division RDA made it very difficult to get information easily.

4 DATA COLLECTION AND ANALYSIS

4.1 Cost Analysis

Road maintenance costs incurred to RDA for following two maintenance methods which are presently used by RDA to maintain the national roads, were calculated for analysis.

- Performance Based Maintenance Contract (PBMC) method
- Conventional maintenance method

Roads, which are maintained through the PBMC method under Northern Road Connectivity Project (NRCP), were selected to calculate the maintenance cost incurred to RDA for PBMC method and other roads which are directly maintained by the RDA through Conventional maintenance method in Northern Province, were selected to calculate the maintenance cost incurred to RDA for Conventional maintenance method. The weather, traffic and terrain conditions were same in selected roads. In both maintenance methods RDA overhead component was neglected since same RDA staffs were worked in both methods.

Table 4.1 Cost Summary for PBMC method applying roads. (NPCP 2013 to 2015)

No	Name of the roads	Length (km)	Contract Price in Million (LKR)	Performance Based Maintenance Cost per Km per month (LKR)			% of total maintenance cost compared to Contract price.
				Year 1	Year 2	Year 3	
1	Dambulla to Thonigala (A009) (74+650-98+000km)	23.35	1,327.00	22,000.00	24,200.00	26,400.00	1.5%
2	Thonagala to Galkulama (A009) (98+000 -122+170)	24.17	1,447.00	1,596.00	7,980.00	8,778.00	0.37%
3	Anuradhapura to Rambewa (A020) (0+000-14+500km)	14.50	752.00	1,596.00	7,980.00	8,778.00	0.42%
4	Nawvathkuli to Kerativu (A032) (0+000-17+400km)	17.4	1,387.00	1,652.00	8,260.00	9,086.00	0.3%
5	Manipay to Kaithady(B268) (0+000-14+020Km)	14.02	629.00	1,680.00	8,400.00	9,240.00	0.52%
6	vallai to Araly road (0+000-27+400km)	27.40	1,484.00	5000.00	5000.00	5000.00	0.33%
7	MankulamMullativu Road A034 0+000 km to 13+000km	13.00	914.00	1,624.00	8,120.00	8,932.00	0.32%
8	MankulamMullativu A034 road 13+000 km to 24+000km	11.00	587.00	2,000.00	3,000.00	4,000.00	0.2%
9	MankulamMullativu Road A03424+000 km to 38+500 km	14.50	928.00	5,925.00	6,518.00	7,110.00	0.37%
10	MankulamMullativu Road A034 38+500 to 49+100km	10.60	1,319.00	36,300.00	38,500.00	41,800.00	1.12%
	Average Performance based Maintenance cost per Km per Month			7,937.30	11,795.80	12,912.40	

Table 4.1 shows that average PBM cost incurred to RDA for year one (2013) is 7,937.30 /km/month, average PBM cost incurred to RDA for year two (2014) is 11,795.80/km/month and average PBM cost incurred to RDA for year three (2015) is 12,912.40 /km/month. Also it shows that total PBM cost incurred to RDA varies from 0.2% to 1.5% of the Contract price.

These cost details were directly extracted from respective contract BOQs and payment deduction made due to noncompliance of Contractor's works and price fluctuation added when making payment to the Contractors were neglected since these amounts were very less compare to above rates and it was very difficult to get those details from RDA. The above roads were maintained by PBM Contractors from 2013 to 2015.

Table 4.2 Cost Summary for PBM method applying roads. (NPCP- AF 2015 to 2019)

No	Name of the roads	Length (km)	Contract Price in Million (LKR)	Performance based maintenance cost per Km per month (LKR)					% of total maintenance cost compared to Contract Price
				Year 1	Year 2	Year 3	Year 4	Year 5	
01	Vavuniya - Horowupathana Road (A029) 24+000 - 34+950	10.95	990.00	3,134	3,447	3,761	4,137	4,550	0.25
02	Medawachchiya - Kebithigollewa Road (B283) 0+000- 12+600	12.6	726.00	5,158	7,539	9,920	11,904	14,285	1.02
03	Medawachchiya - Kebithigollewa Road (B283) 12+600- 25+400	12.8	722.00	1,953	9,375	9,375	9,375	9,375	0.84
04	kebithigollewa - Padaviya Road (B211) 0+000-15+500	15.5	885.00	1,612	7,741	7,741	7,741	7,741	0.68
05	kebithigollewa - Padaviya Road (B211) 15+500- 31+345	15.85	1,020.00	1,577	7,570	7,570	7,570	7,570	0.6
06	Medawachchiya - Mannar Road (A014) 47+000 -62+100	15.1	1,183.00	41,248	43,311	45,476	47,750	50,138	3.5
07	Medawachchiya - Mannar Road (A014) 62+100-76+600	14.5	1,103.00	11,379	12,517	13,768	15,145	16,660	1.1
08	Jaffna - Pannai - Kayts Road (AB019) 0+000- 10+000	10	1,655.00	65,345	68,612	72,043	75,645	79,427	2.6
09	Jaffna - Pannai - Kayts Road (AB019) 10+000-20+270	10.27	1,210.00	63,627	66,808	70,149	73,656	77,339	3.5
Average Performance Based Maintenance Cost per km per month (LKR)				21,670	25,213	26,645	28,103	29,676	

Table 4.2 shows that average PBM cost incurred to RDA for year one (2015) is Rs.21,670.8 /km/month, average PBM cost incurred to RDA for year two (2016) is Rs.25,213.9 /km/month, average PBM cost incurred to RDA for year three (2017) is Rs.26,645.33 /km/month, average PBM cost incurred to RDA for year four (2018) is Rs.28,103.18 /km/month, and average PBM cost incurred to RDA for year five (2019) is Rs.29,676.74 /km/month.

Also Table 4.2 shows that total PBM cost incurred to RDA varies from 0.25% to 3.5% of the contract price. According to the NRCP Bid documents (ADB standard Bid Documents) (2013) there were no limitation for bidders to quote rates for Performance based maintenance works and there are huge variation in rates for Performance based maintenance works among bidders. But in my recent study visit to India (Panjab) in 2015, it was noted that Panjab Works Department (PWD) had put a condition in their bid documents as total maintenance cost should be at least 10% of the total contract price for 10 years maintenance.

These cost details were directly extracted from respective contract BOQ and payment deduction made due to noncompliance of Contractor's works and price fluctuation added when making payment to the Contractors were neglected since these amounts were very less compare to above rates and it was very difficult to get those details form RDA. The above roads are maintaining by the contractor from 2015 to 2019.

To calculate the Conventional maintenance costs incurred to RDA, it was observed that getting road wise costs records for Conventional maintenance works, were very difficult task due to poor records keeping practices in RDA. Therefore road wise cost records were collected only from Executive Engineer's Division Jaffna for limited no of roads, which were rehabilitated in 2012-2014 period with PBM roads. Also, it was observed that, in the Monthly and Yearly cost reports prepared by Provincial Director's office Northern Province RDA, total materials and machineries cost incurred to RDA for routine and recurrent maintenance works were available and Salaries paid for permanent and non-permanent labours also available in RDA salary Division. Those details were collected and used to calculate the Conventional maintenance cost incurred to RDA in Northern Province.

RDA overhead component was neglected since same RDA staffs were worked in both maintenance methods and there was no records available about their involvement in both maintenance methods. Anyway RDA staff involvement in conventional maintenance method is higher than Performance Based maintenance method due direct supervision in the conventional maintenance method.

Table 4.3 Length of roads which are directly maintain by RDA in Northern Province through conventional maintenance method for year 2016.

Executive Engineers Divisions in Northern Province	A' Class (Km)	B' Class (Km)	Total (Km)	Roads maintain through PBMC (Km)	RDA Direct maintenance Roads (Km)
Jaffna	184.36	126.00	310.36	20.27	290.09
Point Pedro	107.00	92.46	199.46	0.00	199.46
Kilinochchi	106.04	53.63	159.67	0.00	159.67
Vavuniya	128.91	57.71	186.62	10.95	175.67
Mannar	113.03	91.28	204.31	29.60	174.71
Mullaitivu	99.92	101.83	201.75	0.00	201.75
Total	739.26	522.91	1262.17	60.82	1201.35

Table 4.3 shows that 1262.17km length of RDA own roads are in Northern Province and out of this nearly 60.82 km length of roads are maintaining through PBMC method in year 2016. Balance 1201.35 km length of roads are directly maintained by RDA through conventional maintenance method in year 2016. For the calculation of average conventional maintenance cost per km per month, it was assumed that every Executive Engineers are equally attending the maintenance works for all roads throughout the year.

Table 4.4 Routine and Recurrent maintenance Cost summary for conventional maintenance method applying roads in Northern Province

Year	Materials and Machinery Cost (LKR.)	Permanent Direct Labour Cost (LKR.)	Non-Permanent Direct Labour Cost (LKR.)	Total Maintenance Cost Per Year (LKR)	Total Length of Roads (Km)	Road Maintenance cost per Km/Year	Road Maintenance Cost per km /month (LKR)
2012	131,191,494.40	32,442,226.60	53,314,224.60	216,947,945.60	1154	187,955.77	15,662.98
2013	117,048,342.87	72,590,624.99	38,209,874.57	227,848,842.43	1154	197,399.91	16,449.99
2014	48,873,231.04	95,407,317.75	47,104,327.03	191,384,875.82	1154	165,808.86	13,817.40
2015	41,269,408.69	167,738,242.97	756,355.51	209,764,007.17	1092	192,015.97	16,001.33
2016	39,879,300.18	156,978,878.98	1,467,111.47	198,325,290.63	1201	165,085.35	13,757.11

For the conventional maintenance cost calculations, year 2012 to year 2016 were considered since the Performance based maintenance contract method was implemented from year 2012.

Table 4.4 shows that average conventional maintenance cost incurred to RDA for year 2012 is Rs.15,662.98/Km/month, average conventional maintenance cost incurred to RDA for year 2013 is Rs.16,449.99/Km/month, average conventional maintenance cost incurred to RDA for year 2014 is Rs.13,817.40/Km/month, average conventional maintenance cost incurred to RDA for year 2015 is Rs.16,001.33/Km/month and average conventional maintenance cost incurred to RDA for year 2016 is Rs.13,757.11/Km/month.

Table 4.5 Cost comparison between average PBM costs incurred to RDA in NRCP and average conventional maintenance cost incurred to RDA in Northern Province.

.Year	Performance Based Maintenance Cost incurred to RDA for Northern Road Connectivity Project. Per Km Per Month (LKR)	Performance Based Maintenance Cost incurred to RDA for Northern Road Connectivity Project-Additional Financing. Per Km Per Month (LKR)	Conventional Maintenance Cost incurred to RDA in Northern Province. per km per month (LKR)
2012	-	-	15,662.98
2013	7,937.30	-	16,449.99
2014	11,795.80	-	13,817.40
2015	12,912.40	21,670.80	16,001.33
2016	-	25,213.80	13,757.11
2017	-	26,645.33	-
2018	-	28,103.18	-
2019	-	29,676.74	-

As per the table no 4.5, it shows that the Contractor has quoted higher rate for PBM in Northern Road Connectivity Project –Additional Financing (NRCP-AF) compared to Northern Road Connectivity Project (NRCP). It may be resulted from their experience they have gain from the NRCP which was started early.

When comparing the average PBM cost incurred to RDA in NRCP and average conventional maintenance cost incurred to RDA in Northern Province, low maintenance cost has been reported in Performance based Maintenance Contract (PBMC) method. Since this is the first time the Contractor has quoted rate for road maintenance in National Highways, they may quoted low rate for road maintenance due to their lack of knowledge and experience about road maintenance. But when comparing the average PBM cost incurred to RDA in NRCP-AF and average conventional maintenance cost incurred to RDA in Northern Province, RDA’s conventional maintenance cost is less compared to PBMC method due to restricted budgets and resources allocated to Maintenance Division.

In order to verify above results, road wise costs incurred to RDA for year 2018, for PBM method and conventional maintenance method, were compared within Executive Engineer’s Division Jaffna. Jaffna- Pannai- Kayts Road (AB 019) was selected to calculate the PBM cost incurred to RDA. Vallai- Thellippalai- Araly Road (B 437), Kandy- Jaffna Road (A09), Jaffna- Kankesanthurai Road (AB 16), Jaffna- Palaly Road (AB 18) and Jaffna- Pointpetro Road (AB 20) were selected to calculate the conventional maintenance cost incurred to RDA. The weather, traffic and terrain conditions were same in selected roads. Also all the selected roads have been rehabilitated with asphalt pavement during 2013 and 2014 periods.

Table 4.6 Routine and Recurrent maintenance Cost summary for conventional maintenance method applying rehabilitated roads in Executive Engineer’s Division Jaffna for year 2018.

Road Name	Materials and Machinery Cost (LKR)	Labour Cost (LKR.)	Total Maintenance Cost (LKR)	Total Length of Roads (Km)	Conventional Maintenance Cost per km /month (LKR)
Vallai- Thellippalai- Araly Road (B437)	36,235.00	1,152,864.91	1,189,099.91	23.83	4,536.30
Kandy- Jaffna Road (A09)	106,601.16	428,189.14	534,790.30	7.25	6,705.83
Jaffna- KKS Road (AB 16)	822,489.50	2,870,180.48	3,692,669.98	18.5	18,145.80
Jaffna- Palaly Road (AB 18)	184,508.49	1,528,911.89	1,713,420.38	17.3	9,003.79
Jaffna- Pointpetro Road (AB 20)	145,002.50	1,693,097.99	1,838,100.49	20.11	8,309.30

Table 4.6 shows that conventional maintenance cost incurred to RDA for rehabilitated roads with asphalt pavement for year 2018.

Table 4.7 Road wise cost comparison between PBM costs incurred to RDA and conventional maintenance cost incurred to RDA in Executive Engineer’s Division Jaffna for year 2018.

Road Name	PBM Cost incurred to RDA Per Km Per Month (LKR)	Conventional Maintenance Cost incurred to RDA per km per month (LKR)
Jaffna- Pannai- Kayts Road (AB 19) (0+000- 10+000)	75,645.00	-
Jaffna- Pannai- Kayts Road (AB 19) (10+000 – 20+270)	73,656.00	-
Vallai- Thellippalai- Araly Road (B 437)	-	4,536.30
Kandy- Jaffna Road (A 09)	-	6,705.83
Jaffna- KKS Road (AB 16)	-	18,145.80
Jaffna- Palaly Road (AB 18)	-	9,003.79
Jaffna- Pointpetro Road (AB 20)	-	8,309.30

Table 4.7 shows that road wise cost incurred to RDA in Executive Engineer’s Division Jaffna for year 2018. When comparing the PBM cost incurred to RDA with conventional maintenance cost, it was revealed that RDA’s conventional maintenance costs are very less compared to PBM costs due to following reasons.

- Executive Engineer, RDA do the maintenance work within the restricted budgets.
- Resources allocated to Maintenance Division, are not enough to do the all the maintenance work. Therefore Executive Engineer not consider about quality of maintenance and he just attends much needed maintenance activities only.
- Executive Engineer gives priority to maintenance of macadam roads than asphalt roads in order to make sure the uninterrupted traffic flow and Passengers Safety.
- PBM Contractor’s may quoted high rates for maintenance considering their profits margin, risks involvement and etc.

4.2 Quality Analysis

Road maintenance quality was evaluated for following two methods which are presently used by the RDA for maintenance of roads.

- Performance Based Maintenance Contract (PBMC) method.
- Conventional maintenance method.

Roads which are maintained through the PBMC method under Northern Road Connectivity Project (NRCP) were selected to evaluate the road maintenance quality for PBMC method. Other roads which are directly maintained by the RDA in Northern Province (NP) were selected to evaluate the road maintenance quality for conventional maintenance method. The weather, traffic and terrain conditions were same in selected roads and also all the selected roads have been rehabilitated with asphalt pavement during 2013 to 2014 periods.

4.2.1 Quality analysis for PBM method applying roads.

In NRCP, There are formal monthly inspections which covers at least 25% of each road, performed jointly by the Contractor and RDA. The results of each formal inspection of the service quality will be recorded by RDA in the form of a report recording the type and location of any non-compliant feature. For each individual case of non-compliance, RDA will determine a date by which the Contractor must have completed the necessary measures in order to remedy the cause of the non-compliance. A follow up site visit will be carried out at the date specified by RDA in order to verify that the cause of non-compliance has been remedied by the Contractor.

In the event that the Contractor fails to remedy the cause of any non-compliance feature noted during the inspection, within the response time applicable to the deficiency and recorded in the Monthly maintenance report, the payment to the Contractor will be subject to reductions. In this case, payment reductions, with respect to any particular case of non-compliance will continue to be imposed on a monthly basis throughout the duration of non-compliance without limit until compliance is established. Respective Executive Engineer RDA act as Engineer for the contract during performance Based maintenance period.

Table 4.8 Performance indicators Applied in NRCP-AF

Mainten ance Element	Defect	Description, Measuremen t, Detection	Allowable Level	Delay Standard Dangerous Defect
Carriage way	Road Roughness	International Roughness Index (IRI)	Not to exceed 4.2	Apply corrective course to defective areas
Roadwa y	Road Closure	Road Closure	Open to traffic and free of Interruptions at all times. Except for lane closures due to emergencies like landslides or flooding, accidents and road works in such cases, the interruptions to traffic shall be kept	The contractor shall inform the Engineer of any lane closures and indicate the location, length and time period of the road closure. lane closures for scheduled road works

			as short as possible. For road works, only one lane shall be closed at a time.	shall be reported to the Engineer at least 24 hours in advance.
Cracking	Measure the width of cracks with transparent ruler. For isolated cracks, the cracked area included the surface 50Cm at both sides of the crack plus 50 cm at each end of the crack.	No cracks wider than 3mm are allowed. For whatever 50m length section, the cracked area will be lower than 10% of the total sealed area.		Cracks shall be sealed within seven days (7) from their detection
Potholes		Potholes with biggest dimension superior to 10cm and depth superior or equal to 2cm		Potholes shall be repaired within seven days (7) from their detection Potholes over 50cm and deeper than 7cm are considered as dangerous and shall be repaired within two (2) days
Localized Patching	Visual Inspection and transparent ruler and 3m rule for verification of the level compared to the carriageway	Patches have to be square, in level with the rest of the carriageway or shoulder, must have been executed using materials similar to the ones used during construction and shall not present cracks wider than 3mm		Non confirming patches shall be redone within seven days (7) from their detection
Edge-Break	Visual Inspection	No edge-break shall be present reducing the width of the carriageway or sealed shoulders by more than 5cm		The affected areas shall be repaired within thirty days (30) from their detection
Rutting	With the use of 2 rulers 3m ruler perpendicular and across the lane and plastic ruler to measure the distance	No rut exceeding 15mm will be present. For every 1km section, no ruts exceeding 10mm and with length over 50m can exist.		The affected areas shall be repaired within thirty days (30) from their detection. If rut exceeds 5cm It is considered as dangerous and shall be repaired within 07 days (7) from their detection.

		between the horizontal 3 m ruler and the lowest point of the rut.		
	Ravelling	Visual Inspection	Ravelled areas of depth greater than or equal to 20mm must not exist.	Ravelled areas must be sealed within 14 days after their detection
	Stripping, peeling, bleeding	Visual Inspection	No stripping, peeling, bleeding should be present over an area representing 5% of the surface of whatever 50m road section.	The affected areas shall be repaired within thirty days (30) from their detection. If bleeding on the carriageway compromises the skid resistance. It is considered as dangerous and will be sanded within two (2) days.
Shoulders (Unsealed)	Height of Shoulder Vs. height of pavement	Difference In height at edge of pavement shall not be more than 50mm.	Measured with ruler, with scale in mm.	The affected shall be repaired within thirty days (30) from their detection. Levels exceeding 100mm are considered to be dangerous and should be repaired within seven (7) days
	Rutting	With the use of 2 rulers: 3m ruler perpendicular and across the lane and plastic ruler to measure the distance between the horizontal 3 mm ruler and the lowest point of the rut.	No rut exceeding 50mm will be present. For every 1km section, no ruts exceeding 30mm and with length over 100m can exist.	The affected areas shall be repaired within thirty days (30) from their detection.
	Erosion deformation	Visual Inspection, transparent ruler, Spirit level	Will not present erosion or deformation superior to 50 mm deep or 200 mm wide. Shall not present negative slopes blocking the water to run out of the carriageway	The affected areas shall be repaired within thirty days (30) from their detection.
Shoulders (Sealed)	Cracking	Measure the width of cracks with transparent ruler. For Isolated	No cracks wider than 3mm are allowed. For whatever 50m length section, the cracked area will be lower than 10% of the total sealed area.	Cracks shall be sealed within seven days (7) from their detection.

		cracks, the cracked area includes the surface 50cm at both sides of the crack plus 50 cm at each end of the cracks.		
	Potholes		Potholes with biggest dimension superior to 10cm and depth superior or equal to 2cm	Potholes shall be repaired within seven days (7) from their detection.
	Localized Patching	Visual Inspection and Transparent ruler and 3m rule for verification of the level compared to the carriageway	Patches have to be square, in level with the rest of the carriageway or shoulder, must have been executed using materials similar to the ones used during construction and shall not present cracks wider than 3 cm	Non-conforming patches shall be redone within seven days (7) from their detection.
	Edge Break	Visual Inspection	No edge-break shall be present reducing the width of the carriageway or sealed shoulders by more than 5cm.	The affected areas shall be repaired within thirty days (30) from their detection.
	Rutting	With the use of 2 rulers: 3m ruler perpendicular and across the lane and plastic ruler to measure the distance between the horizontal 3m ruler and the lowest point of the rut.	No rut exceeding 15mm will be present. For every 1km section , no ruts exceeding 10mm and with length over 50m can exist.	The affected areas shall be repaired with thirty days (30) from their detection. If rut exceeds 5 cm it is considered as dangerous and shall be repaired within 07 days (from their detection .
	Ravelling	Visual Inspection	Ravelled areas of depth greater than or equal to 20mm must not exist.	Ravelled areas must be sealed within 14 days after their detection
	Stripping, Peeling Bleeding	Visual Inspection	No stripping peeling, bleeding should be present over an area representing 5% of the surface of whatever 50m road section.	The affected areas shall be repaired with in thirty days (30) from their detection . If bleeding on the carriageway compromises

				the skid resistance. It is considered as dangerous and will be sanded within two (2) day
Drainage (Longitudinal)	Earth Drains	Visual Inspection	Obstruction shall be less than 10% of the theoretical capacity of the drain	The affected areas shall be repaired within thirty days (30) from their detection.
	Lined Drains	Visual Inspection	Obstruction shall be less than 10% of the theoretical capacity of the drain. Lining without any significant damage of the lining.	The affected areas or damage shall be repaired within thirty days (30) from their detection.
	Covered drains	Visual Inspection	Obstruction shall be less than 10% of the theoretical capacity of the drain. Lining without any significant damage of the lining. Covers should be present and in good condition on the total longitude and no space between covers shall exceed 5 cm	The affected areas or damage shall be repaired within thirty days (30) from their detection. Defective cover or covers with spacing superior to 10cm are considered as dangerous and should be repaired/replaced within seven (7) days.
Drainage (Cross Drainage - Culverts)	Cleaning	Visual Inspection	Obstruction shall be less than 10% of the critical capacity of the drain.	The affected culverts shall be repaired within seven days (7) from their detection.
	Structural Damage	Visual Inspection	Without any significant damage. No erosion should be found.	Damage shall be repaired within thirty days (30) from their detection.
	White Washing	Visual Inspection	Apparent elements shall be clean and white painted with readable marking	The affected culverts shall be white washed within thirty days (30)
Structures	General, Expansion joint, wing walls, slope protections	Visual Inspection	All Structural Damage	Shall inform the client about all defects detected and in particular structural defects compromising the stability of the structure. In the last case, the contractor shall immediately apply security measures as required.
	Metallic Structures	Visual Inspection	Without Corrosion	Corroded areas will be treated and painted within thirty (30) days
	Parapets	Visual Inspection	Shall be present and painted	Parapets with defaults shall be replaced within seven (7) days. If parapets are missing, security chain shall be installed immediately until the parapet is repaired.
	Waterway	Visual Inspection	Shall allow free upstream and downstream over 100m	Origin of non-conformity shall be corrected within fourteen days (14) after the

Signage and Road Safety	Road Marking	Visual Inspection	Shall be present and adhere to the surface. Shall be clean	The affected areas shall be repaired within thirty days (30) from their detection.
	Road Sign Defects	Visual Inspection	Signs shall not present defects, shall be clean and present sufficient reflectivity. Sight of signs shall not be obstructed. Kilometer poles shall be present, readable and painted according the standards.	Noncompliance shall be corrected within fourteen days (14)
	Missing or destroyed signs	Visual Inspection	Replacement	Shall be placed or replaced within fourteen days (14) Provision of signs is at the charges of the Employer
	Security barriers	Visual Inspection	Shall be present were required without important damage exempt of corrosion, painted and white washed.	Non-compliance shall be corrected within fourteen day (14) Heave structural damage is considered as dangerous and should be corrected within four (4) days
ROW	Vegetation and litter control	Visual Inspection	Shall be clean and free of litter. Vegetation shall not be higher than 50-200mm within the ROW except for designated trees. No signs will be obstructed with vegetation and vegetation will not obstruct free water flow	The affected areas shall be cleaned within seven days (7) from their detection.
	Branches above carriageway	Measuring Pole	No Branches above the carriageway or shoulder shall be lower than 6.0m above the surface	The affected areas shall be cleared within seven days (7) from their detection.
	Grass Cutting	Visual Inspection	Grass around signs, structures, barriers shall be kept lower than 25cm within 1m around the element.	The affected areas shall be cleared within seven days (7) from their detection,

Formal monthly inspection reports which were jointly prepared by RDA and PBM Contractors during the monthly inspection for month of July 2017 were collected from the NRCP Project Management Unit RDA and evaluation was carried out as per that reports. Jaffna- Pannai- Kayts Road (AB019) was selected randomly for this evaluation. Date of testing was 9th August 2017. This reports were selected randomly.

Table 4.9 Formal inspection record from 10 km to 11km for JPK Road

1 km Section Inspection										
100 m Sub-segment										
Inspected Maintenance Element.	Check (x) if the segment does not conform									
	1	2	3	4	5	6	7	8	9	10
Road Way	√	√	√	√	√	√	√	√	√	√
Shoulders	√	√	√	√	√	√	√	√	√	√
Structures	√	√	√	√	√	√	√	√	√	√
Drainage	√	√	√	√	√	√	√	√	√	√
ROW	√	√	√	√	√	√	√	√	√	√
Signage and road safety	√	√	√	√	√	√	√	√	√	√

Table 4.10 Formal inspection record from 12 km to 13km for JPK Road

1 km Section Inspection										
100 m Sub-segment										
Inspected Maintenance Element.	Check (x) if the segment does not conform									
	1	2	3	4	5	6	7	8	9	10
Road Way	√	√	√	√	√	√	√	√	√	√
Shoulders	√	√	√	√	√	√	√	√	√	√
Structures	√	√	√	√	√	√	√	√	√	√
Drainage	√	√	√	√	√	√	√	√	√	√
ROW	√	√	√	√	√	√	√	√	√	√
Signage and road safety	√	√	√	√	√	√	√	√	√	√

Table 4.11 Formal inspection record from 14 km to 15km for JPK Road

1 km Section Inspection										
100 m Sub-segment										
Inspected Maintenance Element.	Check (x) if the segment does not conform									
	1	2	3	4	5	6	7	8	9	10
Road Way	√	√	√	√	√	√	√	√	√	√
Shoulders	√	√	√	√	√	√	√	√	√	√
Structures	√	√	√	√	√	√	√	√	√	√
Drainage	√	√	√	√	√	√	√	√	√	√
ROW	√	√	√	√	√	√	√	√	√	√
Signage and road safety	√	√	√	√	√	√	√	√	√	√

Table 4.12 Formal inspection record from 16 km to 17km for JPK Road

1 km Section Inspection										
100 m Sub-segment										
Inspected Maintenance Element.	Check (x) if the segment does not conform									
	1	2	3	4	5	6	7	8	9	10
Road Way	√	√	√	√	√	√	√	√	√	√
Shoulders	√	√	√	√	√	√	√	√	√	√
Structures	√	√	√	√	√	√	√	√	√	√
Drainage	√	√	√	√	√	√	√	√	√	√
ROW	√	√	√	√	√	√	√	√	√	√
Signage and road safety	√	√	√	√	√	√	√	√	√	√

As per the above tables no 4.9, 4.10, 4.11 and 4.12, it shows that the Contractor has maintained Jaffna-Pannai-Kayts Road (AB019) as per the RDA requirement stipulated in the Contract during the month of July 2017. There was no payment reduction been made during the month of July 2017. In this analysis, it was assumed that Executive Engineer RDA has prepared these reports honestly during the site inspection.

To verify the above results, a personal site visit was carried out to PBMC roads to check the quality of maintenance work. Jaffna - Pannai - Kayts Road (AB019) and Medawachchiya - Mannar Road (A014) were selected for the site visit. In the site inspection, it was observed that the Contractors are maintaining the roads with a high quality. There are contractor's team which led by a technical officer always at site and attending the maintenance work as per the RDA requirement. It was very hardly to find the defects on the roads. Road users are satisfied with the road maintenance quality. The photos were taken randomly along the roads in 0.5 to 1 km interval.



Figure 4.1 PBM Roads (AB019)



Figure 4.2 PBM Roads (AB019)



Figure 4.3 PBM Roads (AB019)



Figure 4.4 PBM Roads (AB019)



Figure 4.5 PBM Roads (AB019)



Figure 4.6 PBM Roads (AB019)



Figure 4.7 PBM Roads (AB019)



Figure 4.8 PBM Roads (AB019)

4.2.2 Quality analysis for Conventional maintenance method applying roads

A site inspection was carried out to conventional maintenance method applying roads which are directly maintained by RDA, to evaluate the quality of maintenance work. Vallai-Araly Road (B437) was selected randomly for the site inspection. Same format of monthly inspection report which was used to evaluate PBM roads was used to evaluate the quality of maintenance work. 2km section from 18km post to 20km post was selected randomly for the evaluation. In the site inspection, it was observed that road maintenance quality of this road was very poor. A Technical officer who participating in PBM method applying roads inspection also participated for this inspection.

It was very easy to find the defects on this road. Most of the defects are on shoulder erosion, no vegetation control in ROW and siltation and waste materials in Drainage. There are some cracks in the Asphalt pavement also observed. The photos were taken randomly along the roads in 0.5 to 1 km interval.

Table 4.13 Formal inspection record from 19 km to 20km for Vallai- Araly Road

1 km Section Inspection										
100 m Sub-segment										
Inspected Maintenance Element.	Check (x) if the segment does not conform									
	1	2	3	4	5	6	7	8	9	10
Road Way	√	√	√	√	x	√	√	√	√	x
Shoulders	x	x	x	√	x	x	x	√	x	x
Structures	√	√	√	√	√	√	x	√	√	√
Drainage	x	√	√	√	√	x	√	x	√	√
ROW	x	x	x	√	x	x	x	x	x	x
Signage and road safety	√	√	√	√	√	√	√	√	√	√

Table 4.14 Formal inspection record from 18 km to 19km for Vallai Araly Road

1 km Section Inspection										
100 m Sub-segment										
Inspected Maintenance Element.	Check (x) if the segment does not conform									
	1	2	3	4	5	6	7	8	9	10
Road Way	√	√	√	√	√	√	x	x	√	√
Shoulders	x	√	x	x	√	√	x	x	x	√
Structures	√	√	x	√	√	√	x	√	√	√
Drainage	√	x	√	x	√	x	√	x	x	x
ROW	x	x	x	x	√	√	x	x	x	x
Signage and road safety	√	√	√	√	√	√	√	√	√	√



Figure 4.9 Conventional maintenance Roads (B437)



Figure 4.10 Conventional maintenance Roads (B437)



Figure 4.11 Conventional maintenance Roads (B437)



Figure 4.12 Conventional maintenance Roads (B437)



Figure 4.13 Conventional maintenance Roads (B437)



Figure 4.14 Conventional maintenance Roads (B437)

When comparing maintenance quality of Performance based maintenance method applying roads and Conventional maintenance method applying roads, higher quality of maintenance works have been reported in Performance based Maintenance (PBM) method and Lower quality of maintenance works have been reported in Conventional maintenance method.

Higher quality of maintenance works have been reported in Performance Based Maintenance method due to following reasons.

- The Contractor attending the maintenance work in proper time (at initial stage of defect)
- The Contractor maintained high quality of construction work during the construction stage since they need to maintain the same roads another 3 to 5 years.
- The Contractor pays higher attention for quality of maintenance work since it will affect the performance indicator.
- Greater flexibility in the private sector than in the public sector to react quickly against the defects.

Low quality of maintenance works have been reported in conventional maintenance method due to following reasons.

- RDA maintenance division attending the defects after its get worse condition due to restricted fund allocation, follow lot of formalities, negligence of officer in charge and etc.
- Low productivity from the RDA permanent labor force.
- Shortage of labours and insufficient fund allocation in RDA maintenance division.
- Careless and negligence among RDA staff and labour about quality of maintenance work.

4.3 Questionnaire survey with RDA Engineers.

Questionnaire surveys have been the most widely used mechanism to obtain information from the professionals in the past. Response rate for mail questionnaire is poor in many cases compared to face to face interviews. Considering these aspects, a mixed methodology was adopted for this research which comprises of field visits and distributing questionnaire by hand and face to face interviews. This survey was conducted among RDA Engineers who are working in NRCP Project Management Unit RDA and Maintenance Division Northern Province RDA, to get their opinion according to their perception and experience about PBMC method.

Among 27 selected Engineers, 20 Engineers have responded to the survey. It included 6 Engineers from the NRCP PMU and 14 Engineers from the maintenance division RDA.

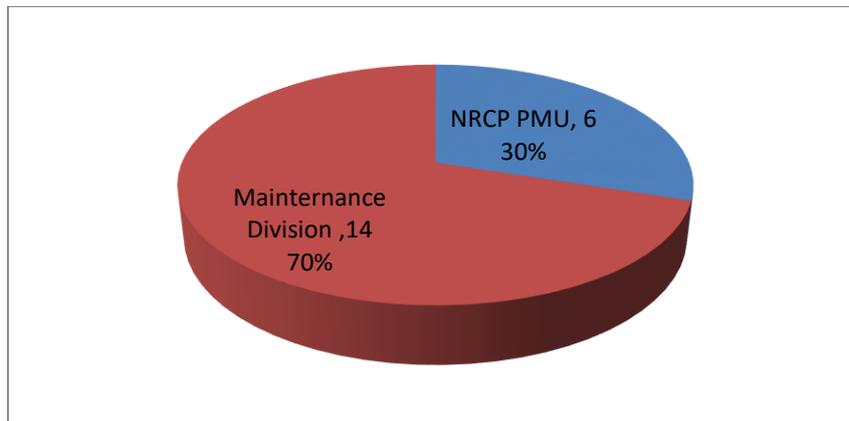


Figure 4.15 Participation of involved parties

The summary of the answers given by them are categorized.

1. Type of Road maintenance you have involved with?

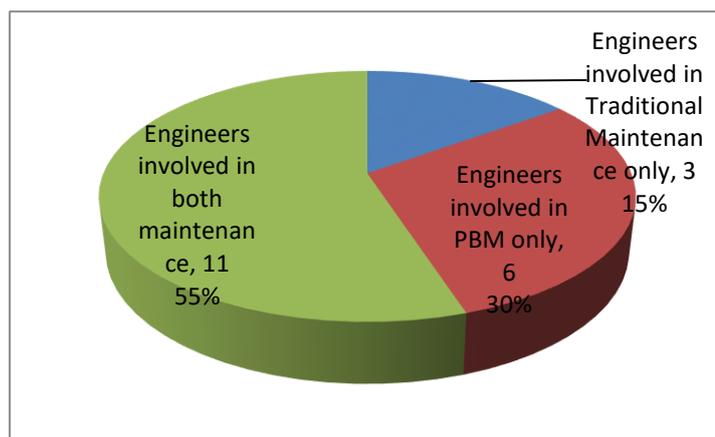


Figure 4.16 Response received for question No. 1

Most of the Engineers who participated in questionnaire survey, have involved in PBM and only 15% of participation do not have PBM experience.

2. No of PBMC projects you have involved?

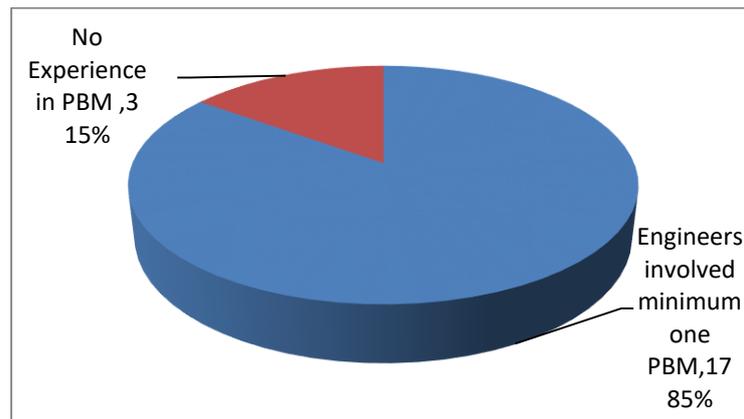


Figure 4.17 Response received for question No. 2

Majority of Engineers involved at least one PBM project.

3. With your experience, do you think that PBMC method is beneficial for RDA?

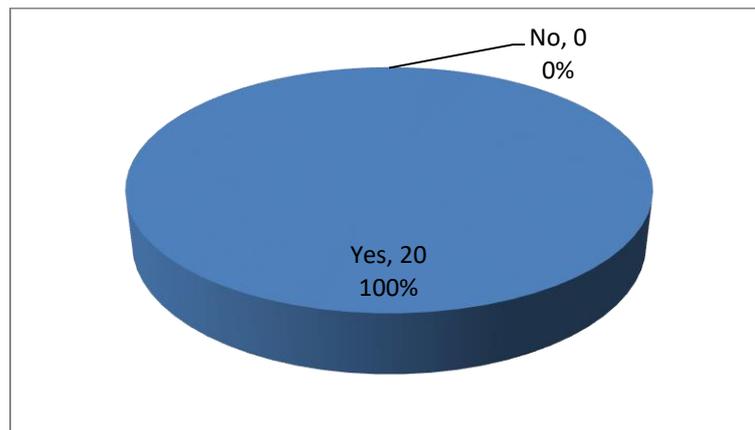


Figure 4.18 Response received for question No. 3

Almost all the Engineers in RDA accepted that PBMC Project is beneficial for RDA.

If yes, what are the benefits you have identified?

1. Quick response than RDA direct maintenance work.
2. Quality of rectification is up to construction standard.
3. No formalities prior to attend works
4. Less RDA staff involvement (minimum supervision)
5. Less fraudulent practices
6. It gives solution for RDA labour shortage and fund allocation shortage problems.
7. Maintenance fund certainty for certain period.
8. The Contractor paid high attention to quality of construction work since they are going to do the maintenance work for another 3 to 5 years.
9. Increased the life time of road assets due to proper maintenance.

4. In NRCP maximum PBM period is 5 years, with your experience do you think that we can increase the PBM period?

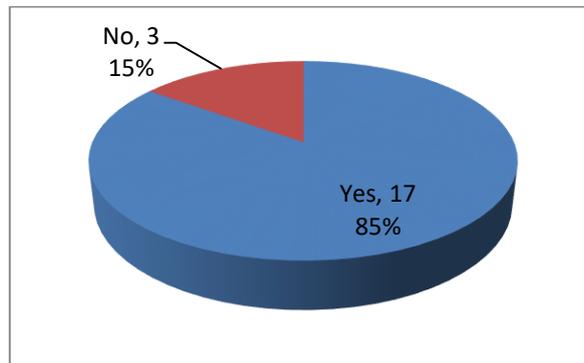


Figure 4.19 Response received for question No. 4

Majority of Engineers accepted that present PBM period is not enough for getting benefits from PBMC method and they have proposed that it is better to increase the PBM period since design life of road is more than 5 years.

If yes, How long?

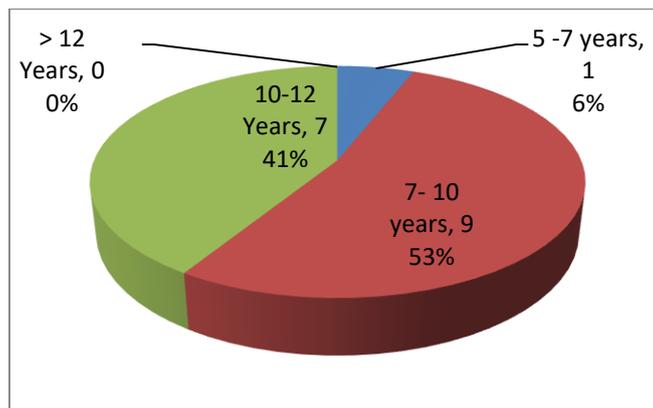


Figure 4.20 Response received for question No. 4

Majority of Engineers proposed that increase the PBM period to 7 -10 years.

5 What type of maintenance activities can be included in PBMC?

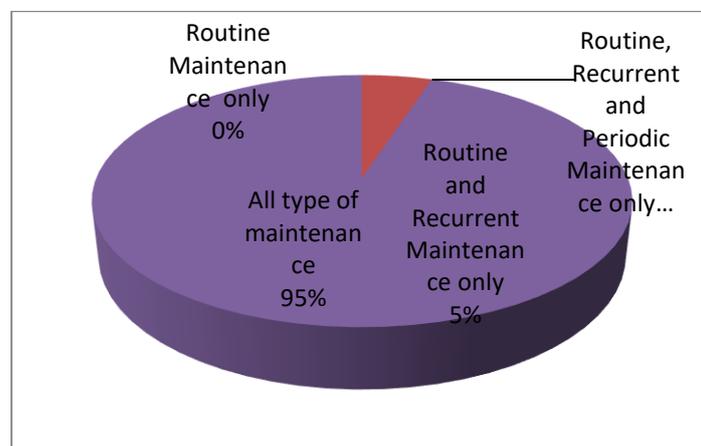


Figure 4.21 Response received for question No. 5

Almost all the Engineers proposed that all type maintenance activities such as routine maintenance, recurrent maintenance, periodic maintenance and urgent maintenance can be included in PBMC. As per the NRCP contract document, periodic maintenance works are not included in the contract document. Therefore the RDA engineers have proposed that increase the PBM period 7-10 years with a Periodic maintenance works.

6 Do you think that Sri Lankan Contractors has experience to do the maintenance work as per RDA standard?

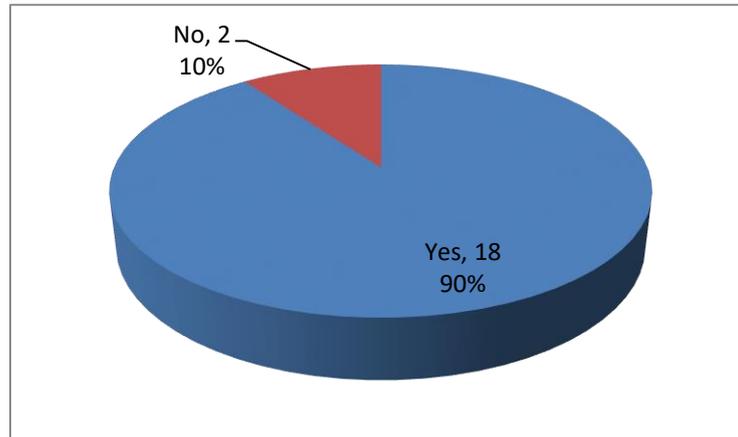


Figure 4.22 Response received for question No. 6

Majority of RDA Engineers accepted that Sri Lankan Contractors has experience to do the road maintenance works since these works are supervised by RDA staff.

7. When retention money and performance certificate will be released?

Retention money will be released after construction period. Performance certificate will be released after Defect Notification Period and separate performance certificate will be requested from the Contractor for the maintenance period.

8 Whether the Contractor achieves the performance indicators throughout the PBM period?

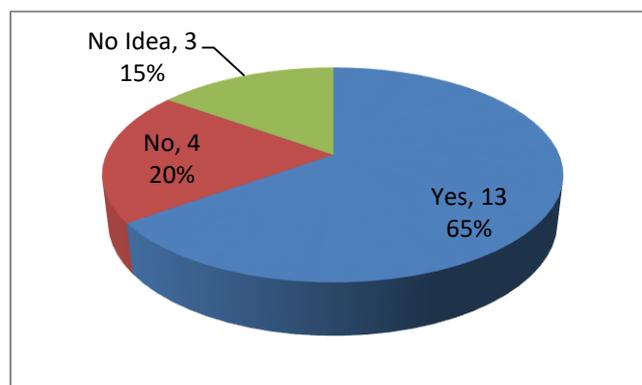


Figure 4.23 Response received for question No. 8

Majority of Engineers accepted that the Contractor achieves the performance indicator throughout the PBM periods. Also they said that sometimes they fail to achieve some performance indicator.

9 If the Contractor did not achieve the Performance Indicator. Are you applying the penalty as per the Contract?

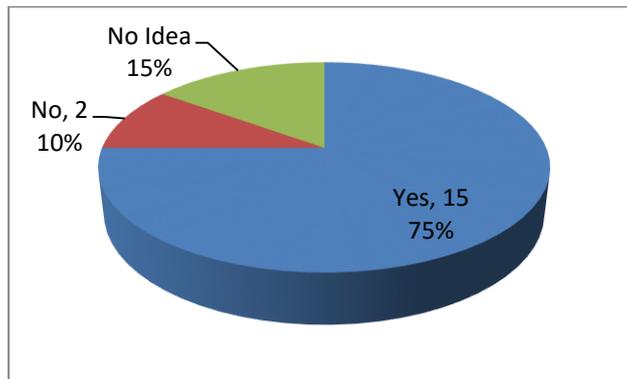


Figure 4.24 Response received for question No. 9

Majority of RDA Engineers said that they are applying penalty if the Contractor did not achieve the performance indicators as per the Contract.

10 Whether the Contractor attends the emergency work as soon as possible?

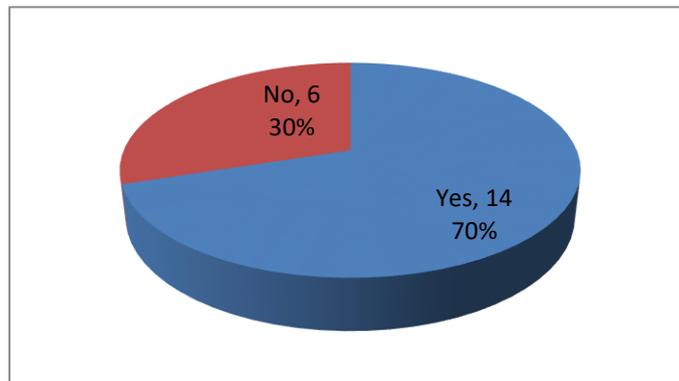


Figure 4.25 Response received for question No. 10

Majority of Engineers in RDA accepted that the Contractor attends the emergency work as soon as possible. Anyway some Executive Engineers said that it is difficult to contact correct person from the Contractor's side since they are not maintain the site office during the PBM period.

11 If there is design failure occurred during the maintenance period, how do you deal with such situation?

Since this is not a Design and built Contract, the Contractor will not take design responsibility. Employer or Design Consultant is responsible for the design failure. Anyway they said that still they do not have such experience. All the rectification works are carried out by the Contractor.

12 If the road damaged due to Utility agencies during the maintenance period, how do you deal with that situation?

With the negotiation, the damages are paid by the respective Utility agencies to the Contractor. Then the Contractor will do the rectification works.

13 If the road furniture's damaged by the third party within the Contract period, how do you deal with that situation?

The accidents cases are deal by police and penalty from victim is asked to pay to the Contractor through EE. Then the Contractor will do the rectification works. In other cases the Contractor refuse to attend the work without additional payment.

14 When you implementing PBMC Project, what are the other challenges you have faced?

1. Un authorised digging on the roads
2. Irresponsible behaviour of the public (Mudding the road, scarifying road, painting on the roads, pasting posters on the boards, putting waste on the roads & Drainage)
3. Difficult to contact correct person from the Contractor's side to attend any emergency work since they are not maintaining proper site office during the PBM period.
4. The Contractor is not treating PBM as a part of the Contract
5. The Contractor attend the maintenance work just before the inspection
6. The Contractor not willing to attend the third party damages.
7. Lack of knowledge and experience about PBMC in RDA maintenance division.
8. Loan agreement is expired before completion of contract. So making payment to the Contractor is difficult.

15. What are the improvements or modification can be made for this Contract to overcome these Challenges?

1. Providing a provisional Sum (PS) to rectify unidentified damages.
2. Suggesting the Contractor to take insurance for these types of damages.
3. Teach General public to not damage the roads and road furniture.
4. Taking legal action again who damages the roads.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Road maintenance is essential in order to preserve the road to serve for design life, avoid premature failures, protect adjacent resources and user safety, and provide efficient, convenient travel along the route. Unfortunately, road maintenance is often neglected or improperly performed resulting in rapid deterioration of the road and eventual failure from both climatic and vehicle use impacts.

At present, two maintenance methods are practiced by RDA to carry out the maintenance works for the National Highways in Northern Province Sri Lanka. They are conventional maintenance methods and Performance based maintenance method. Most of the RDA roads in Northern Province, are maintained through conventional maintenance methods and currently some of the RDA roads are maintained through the Performance based maintenance contract method in experimental level.

In Northern Province, conventional maintenance works are carried out through direct labours of the organizations. Material required for road maintenance works are supplied by various suppliers, who registered under RDA. RDA use their own machinery or sometimes use hired machinery for road maintenance activity.

RDA has been practising Performance based maintenance contracting method to carry out construction and maintenance works of the roads from 2009 under Asian Development Bank funded Northern Road Connectivity Project. In Performance based maintenance contract method, the Contractor was undertaken to carry out maintenance of the roads for a continuous period depending on the contract, from the date of issue of the Taking over certificate for which the Contractor will be paid separately as a monthly payment depending on performance indicators he has achieved during the particular month.

This research was carried out to identify the benefits achieved by RDA through implementing the PBMC method, challenges faced by the Authorities when implementing the PBMC method and mitigation measures to overcome the above challenges.

5.2 Conclusions

5.2.1 Benefits achieved by RDA through implementing the PBMC method.

This study compared conventional maintenance methods and performance based maintenance method. From the comparison, it was found that the roads which are maintained through the PBMC method are in better conditions compared to non PBMC roads, which are directly maintained by RDA through conventional maintenance method. Also this study revealed that RDA's conventional maintenance method cost is less compared to PBMC method.

Higher quality of maintenance works have been reported in Performance based Maintenance contract method due to following reasons.

- The Contractor attending the maintenance work in proper time (at initial stage of defect)
- The Contractor maintained high quality of construction work during the construction stage since they need to maintain the same roads another 3 to 5 years.
- The Contractor pays higher attention for quality of maintenance work since it will affect the performance indicator.
- Greater flexibility in the private sector than in the public sector to react quickly against the defects.

Low quality of maintenance works have been reported in conventional maintenance method due to following reasons.

- RDA maintenance division attending the defects after its get worse condition due to restricted fund allocation, follow lot of formalities, negligence of officer in charge and etc.
- Low productivity from the RDA permanent labor force.
- Shortage of labour and fund allocation in RDA maintenance division.
- Careless and negligence among RDA staff and labour about quality of maintenance work.
- No financial or other benefits for labours and supervisors for achieving better quality work.

RDA's conventional maintenance costs are very less compared to PBM costs due to following reasons.

- Executive Engineer, RDA do the maintenance work within the restricted budgets.
- Resources allocated to Maintenance Division are not enough to do the all the maintenance work. Therefore Executive Engineer not consider about quality of maintenance and he just attends much needed maintenance activities only.
- Executive Engineer gives priority to maintenance of macadam roads than asphalt roads in order to make sure the uninterrupted traffic flow and Passengers Safety in the Division.
- PBM Contractor's may quoted high rates for maintenance considering their profits margin, risks involvement and etc.

The study further found that RDA has achieved following benefits through implementing performance based maintenance contract method.

- Performance based maintenance contract method give solutions for labour shortage and inadequate fund allocation faced by RDA maintenance Divisions.
- Performance based maintenance contractors quickly response to maintenance activities than the conventional maintenance method due to higher flexibility in private sector.
- Minimum supervision is required for the performance based maintenance contract method since the Contractor is contractually bound to achieve certain performance standard specified in the contract document and Payments for the Contractors are

- made only if he complies with the performance standard. Therefore, it reduces the work load of the RDA supervising staff.
- Less fraudulent practices due to higher private sector involvement in performance based maintenance contract method.

5.2.2 Challenges faced by the Authorities when implementing the PBMC method.

In addition to benefits achieved by the RDA through implementing performance based maintenance contract method, this study was identified challenges faced by RDA when implementing the performance based maintenance contract method for maintaining the roads in Northern Province.

They are,

- Irresponsible behavior of the public (Directing waste water flows to the road, damaging Asphalt pavement and Shoulders, painting on the Asphalt surface, bridges ,culverts and hard stones, pasting posters on the sign boards, bridges, culverts and hard stones, dumping waste on the road sides & Drainages and etc) and Performance based maintenance Contractor's reluctance to attend the damages cause by third parties.
- The Contractors not treat Performance based maintenance period as a part of the main Contract.
After completion of Rehabilitation and Improvement work, the Contractors are demobilizing their resources to some other Project and handling the Performance based maintenance period from that location to reduce their overhead costs. One or two technical staff and few labours are at site to do the maintenance work. Also they are not keeping site offices during the performance based maintenance period. Therefore it was difficult for Executive Engineers RDA to contact correct person for attending the emergency situation.
- The Contractor attend the maintenance work just before the RDA inspection.
In Northern Road Connectivity Project, There are formal monthly inspections which covers at least 25% of each road, performed jointly by the Contractor and RDA. Payments to the Contractors are made based on reports prepared after formal monthly inspections. It was identified that some Contractors are not attending the maintenance work throughout the month and they are doing the maintenance work just before the RDA formal inspection.
- Lack of knowledge and experience about PBMC method.
Performance based maintenances method is new concept for RDA staff since this method of contract was adopted in the country only Eight years back. In the questionnaire survey it was identified that some RDA staff has lack of knowledge and experience about Performance based maintenances method. They don't have clear idea about performance indicators, how to measure the performance indicators and what are the actions need to be taken if the PBM Contractor did not achieve the performance standard specified in the contract document and etc.

- Making payment to the Contractor after loan agreement get expired.
As per the Northern Road Connectivity Project- Additional Financing contract documents, Construction Period is 2 years and Performance based maintenance period is 5 years. All together contract period is 7 years. But loan agreement sign by Government of Sri Lanka and Asian Development Bank will expired after 3 years maintenance period. Thereafter making payment to the Contractor is a challenge task for RDA.
- Deficiencies in the Contract Documents.
Since Performance based maintenance contracts are still in an early stage of development, there are deficiency in the Northern Road Connectivity Project Contract documents.
 - There is no provision in the contract documents to handle the situation like third party damages the roads, since this is beyond the Contractor's control.
 - There is no control over the rate quoted by the Contractor for the performance based maintenance. It was noted that some Contractors has quoted very low rate like Rs.1600.00/km/month while some experience Contractors like Mage Engineering (Pvt) ltd quoted rate like Rs.65000.00/km/month and the Contractors who quoted very low rate for performance based maintenance didn't perform well during the Performance based maintenance period.

5.3 Recommendations

Based on the study the following recommendations are given to RDA.

- Performance based maintenance period can be increase to 7-10 years with a periodic maintenance work.
The duration of the contract should be sufficient to achieve the full benefit of the PBMC method. Performance Based Maintenance period for NRCP is 3 to 5 years. Most of the other countries has extended their maintenance period up to 3 to 10 years. The longer the contract period is the incentive for the Contractor to try and apply new technologies, carryout higher quality work and to optimize resource allocation.
- Training Programs can be arranged for RDA supervising staff and the Contractor about PBMC.
Well qualified staff and the Contractors are key to the success of Performance Contracts. Training programs which have been conducted for small scale enterprises and inspectors in Uruguay and Honduras have shown good results.
- The PBM Contract document can be modified based on lesson learn from the previous project.
Performance Contracts are still in an early stage of development. Studying the experiences of existing Performance Contracts in other countries and lesson learn from the previous project is recommended when modifying the contract document.

- The financial commitment can be made for the entire contract period before starting such a long PBM Contract.
Normally, Performance based maintenance contracts have duration between 4 and 10 years. Therefore it is important to secure financing for the entire contract period before starting such a contract. RDA need to be discussed with donor agency such as World Bank and Asian Development Bank regarding this issues before signing the loan agreement.
- Educate the people about their irresponsible behavior and enforce the law on people who made damages to the roads. In Popayan, they managed to educate the people not to throw garbage on the roads or sidewalks, which is a common problem in urban areas.
- Providing a provisional Sum (PS) to rectify unidentified damages (Third Party damages).

5.4 Recommendations for future studies.

Further research can be focus in following areas will be useful to improvements of PBMC method in Sri Lanka.

- Comparison of Performance indicators in other countries and Sri Lanka and give suggestion for improvement of Performance indicators which is used in Sri Lanka.

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APPENDIXES

Appendix- A Sample Questionnaire

Questionnaire for Reviewing the Application of Performance Based Maintenance Contracting (PBMC) for Roads in Northern Province.

- Sample for the study: National Highways which were improved and PBM method is applying under Northern Road Connectivity Project (NRCP) RDA and National Highways which are maintained by Maintenance Division Northern Province RDA.
- The main purpose of this questionnaire is to identify the benefits achieved RDA through Implementing the PBMC method for Roads and Challenges faced by the Authorities when implementing the PBMC method for Roads.
- During this survey we assure your privacy and we request your honest and kind cooperation.

Section 01

Please fill in the blanks

Date:

Designation:

Division/Department:

Involvement to PBMC Project: Project Management Unit, RDA

: Road Maintenance Division, RDA

Section 02

Please state “√ “in the given box and write your comments in the given blanks.

1. Type of Road maintenance you have involved with?

Conventional Maintenance PBM other.....

2. No of PBMC projects you have involved?

3. With your experience, do you think that PBMC is beneficial for RDA?

Yes No

If yes, what are the benefits you have identified? Please comment.

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.....

4. In NRCP maximum PBM period is 5 years. With your experience, do you think that we can increase the PBM period?

Yes No comments.....

If yes, How long?

5-7 years 7-10 years 10-12 years > 12 years

5. What type of maintenance activities can be included in PBMC method? You can tick more than one answer.

Routine Maintenance Recurrent Maintenance

Periodic Maintenance Urgent Maintenance

6. Do you think that Sri Lankan Contractors has experience to do the maintenance work as per the RDA Standard?

Yes No Comments.....

7. When retention money and performance certificate will be released?

Retention money After construction period After Maintenance period

Performance certificate After construction period After Maintenance period

Comments.....

8. Whether the Contractors achieves the performance indicators throughout the PBM period?

Yes No, Reasons.....

9. If the Contractors did not achieve the performance Indicators, Are you applying the penalty as per the Contract?

Yes No, Reasons.....

10. Whether the Contractor attends the emergency work as soon as possible?

Yes No, Reasons.....

11. If there is design failure occurred during the maintenance period, how do you deal with such situation? Please comment.

.....
.....
.....

12. If the road are damaged due to Utility agencies during the maintenance period, how do you deal with such situation? Please comment.

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.....

13. If the road furniture's are damaged by the third party within the PBM period, how do you deal with such situation? Please comment.

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14. When you implementing PBMC Project, What are the other challenges you have faced? Please comment.

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15. What are the improvements or modifications can be made for this Contract to overcome these challenges? Please comment.

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Appendix- B Questionnaire Survey outcome summary

Questionnaire for Reviewing the Application of Performance Based Maintenance Contracting (PBMC) for Roads in Northern Province.

Participation:	Project Management Unit, RDA	6
	Road Maintenance Division, RDA	14
	Total	20

1. Type of Road maintenance you have involved with?

Conventional Maintenance only- 3

PBM only- 6

Both maintenance – 11

2. No of PBMC projects you have involved?

No PBM Experience – 3

Involved minimum one PBM – 17

3. With your experience, do you think that PBMC is beneficial for RDA?

Yes -20

No – 0

If yes, what are the benefits you have identified? Please comment.

- Quick response than RDA direct maintenance work.
- Quality of rectification is up to construction standard.
- No formalities prior to attend works
- Less RDA staff involvement (minimum supervision)
- Less fraudulent practices
- It gives solution for RDA labour shortage and fund allocation shortage problems.
- Maintenance fund certainty for certain period.
- The Contractor paid high attention to quality of construction work since they are going to do the maintenance work for another 3 to 5 years.
- Increased the life time of road assets due to proper maintenance

4. In NRCP maximum PBM period is 5 years. With your experience, do you think that we can increase the PBM period?

Yes -17

No - 3

If yes, How long?

5-7 years - 1

7-10 years - 9

10-12 years -7

> 12 years - 0

5. What type of maintenance activities can be included in PBMC method? You can tick more than one answer.

Routine Maintenance only - 0

Routine and Recurrent Maintenance only- 1

Routine, Recurrent and Periodic Maintenance only- 0

Routine, Recurrent, Periodic and Urgent Maintenance – 19

6. Do you think that Sri Lankan Contractors has experience to do the maintenance work as per the RDA Standard?

Yes - 18

No - 2

7. When retention money and performance certificate will be released?

Retention money will be released after construction period. Performance certificate will be released after Defect Notification Period and separate performance certificate will be requested from the Contractor for the maintenance period.

8. Whether the Contractors achieves the performance indicators throughout the PBM period?

Yes -13

No -4

No idea – 3

9. If the Contractors did not achieve the performance Indicators, Are you applying the penalty as per the Contract?

Yes – 15

No – 2

No idea – 3

10. Whether the Contractor attends the emergency work as soon as possible?

Yes -14

No -6

11. If there is design failure occurred during the maintenance period, how do you deal with such situation? Please comment.

Since this is not a Design and built Contract, the Contractor will not take design responsibility. Employer or Design Consultant is responsible for the design failure. Anyway they said that still they do not have such experience. All the rectification works are carried out by the Contractor.

12. If the road are damaged due to Utility agencies during the maintenance period, how do you deal with such situation? Please comment.

With the negotiation, the damages are paid by the respective Utility agencies to the Contractor. Then the Contractor will do the rectification works.

13. If the road furniture's are damaged by the third party within the PBM period, how do you deal with such situation? Please comment.

The accidents cases are deal by police and penalty from victim is asked to pay to the Contractor through EE. Then the Contractor will do the rectification works. In other cases the Contractor refuse to attend the work without additional payment.

14. When you implementing PBMC Project, What are the other challenges you have faced? Please comment.

- Un authorised digging on the roads
- Irresponsible behaviour of the public (Mudding the road, scarifying road, painting on the roads, pasting posters on the boards, putting waste on the roads & Drainage)
- Difficult to contact correct person from the Contractor's side to attend any emergency work since they are not maintaining proper site office during the PBM period.
- The Contractor not treat PBM as a part of the Contract
- The Contractor attend the maintenance work just before the RDA inspection
- The Contractor's reluctance to attend damages cause by third party.
- Lack of knowledge and experience about PBMC in RDA maintenance division.
- Loan agreement get expired before completion of contract. So making payment to the Contractor is difficult.

15. What are the improvements or modifications can be made for this Contract to overcome these challenges? Please comment.

- Providing a provisional Sum (PS) to rectify unidentified damages.
- Suggesting the Contractor to take insurance for these types of damages.
- Teach General public not damage the roads and road furniture.
- Taking legal action again who damages the roads.