

An Overview of Issues to Consider Before Introducing Performance-Based Road Maintenance Contracting

M. Sultana, A. Rahman, S. Chowdhury

Abstract—Road authorities have confronted problems to maintaining the serviceability of road infrastructure systems by using various traditional methods of contracting. As a solution to these problems, many road authorities have started contracting out road maintenance works to the private sector based on performance measures. This contracting method is named Performance-Based Maintenance Contracting (PBMC). It is considered more cost-effective than other traditional methods of contracting. It has a substantial success records in many developed and developing countries over the last two decades. This paper discusses and analyses the potential issues to be considered before the introduction of PBMC in a country.

Keywords—Contracting, Performance-Based Maintenance, Road infrastructure

I. INTRODUCTION

ROAD authorities have confronted problems to maintaining the serviceability of the road infrastructure systems by using various traditional methods of contracting. Traditional methods of road maintenance contracts depend on the amount of work executed and contractors are paid by the road authority based on mutually agreed unit rates. On the other hand, Performance-based Maintenance Contracting (PBMC) for road infrastructure systems are based on the outcome of the contractors work and payments are made subject to contractors' ability to achieve the performance standard defined in the contract, and not on the amount of works executed [1]. Moreover, the nature of PBMC allocates the risk and responsibility to the contractors. The long term performance-based contracts motivate the contractors to use innovative technologies and render quality works.

Many developed and developing countries have succeeded in effectively minimizing infrastructure maintenance costs and managing time using performance-based maintenance contracts over the last two decades. The amount of literature and research on PBMC is reasonably high although the concept is relatively new. As PBMC is a long-term contract, introduction of PBMC for road infrastructure maintenance in a country requires massive planning and a cultural change among the road authority.

This paper discusses and analyses a large number of published studies on PBMC to present an overview of the potential issues to be considered before the introduction of PBMC in a country.

II. PERFORMANCE-BASED MAINTENANCE CONTRACTING (PBMC)

Performance based maintenance of road infrastructure by contracting (PBMC) is a method under which the selected contractor has to plan, design and implement maintenance activities in order to achieve short and long term road condition standards for a fixed price, subject to the specified risk allocation [2].

PBMC may motivate the contractors to implement better-quality maintenance practices and improve the overall condition of road assets during the contract period. In PBMC, payments are made after checking that the contractor is meeting the performance standards defined in the contract [1]. PBMC reduces the cost and time of road maintenance by applying well-organized and time saving work methods and technologies.

The successful applications of PBMC have been observed in many developed and developing countries, such as in Canada (British Columbia, 1988) Argentina (1990), Australia (1995), USA (1996), Uruguay (1996), Chile (1997), New Zealand, Columbia, Brazil, Finland (1998), Zambia (1999), Peru, and Guatemala [3]. This trend has also spread to Europe, Africa and Asia, for example, the UK, Sweden, Netherlands, Norway, France, Estonia, Serbia and Montenegro, South Africa, Chad, and the Philippines [4]. PBMC are also referred to as Performance-based Contracts (PBC), Asset Management Contracts (in USA), Performance Specified Maintenance Contracts in Australia and New Zealand (PSMC), Performance-based Road Maintenance Contracts (PBRMC), CREMA (Contrato de Recuperation y Mantenimiento which means Contract for Rehabilitation and Maintenance) in Argentina and other Latin American countries, Managing Agent Contracts (MAC) in the UK, and Area Maintenance Contracts in Finland.

III. BENEFITS OF PBMC

The beneficial areas of PBMC mentioned in the literature are as follows: savings of cost for road maintenance works, risk sharing and assurance of quality by the contractor, introduction of innovation, increasing the efficiency of the road authority and contractors, reducing the administrative burden, user satisfaction, achieving a sustainable road

M. Sultana is an M.Phil. Candidate in Griffith School of Engineering, Griffith University, Gold Coast, Queensland, Australia (Phone: +61 07 55529057, e-mail: m.sultana@griffith.edu.au)

A. Rahman is a Lecturer in Griffith School of Engineering, Griffith University, Gold Coast, Queensland, Australia (Phone: +61 07 55528255, e-mail: a.rahman@griffith.edu.au).

S. Chowdhury is a Senior Lecturer in Griffith School of Engineering, Griffith University, Gold Coast, Queensland, Australia Phone: (+61 07 55528262, e-mail: s.h.chowdhury@griffith.edu.au).

management system, increasing the flexibility of work, and increasing transparency and reducing the chance of corruption.

PBMC requires less administrative effort than the earlier type of contracts [4]. On average, the indirect costs to contractors are 21% lower in PBMC, since contractors can improve their internal business process with more efficient manpower, equipment and materials due to the long term nature of PBMC [5]. Use of modern technologies, materials and techniques also has the capability of reducing noise and other environmental impacts which will help to reduce the negative impacts of construction works on the public [6]. The contractors must ensure that the roads under contract comply with the service quality levels which have been specified in the bidding documents to receive the monthly payment for maintenance services. It is possible that during some months they will have to carry out a large amount of physical works in order to comply with the required service levels and very little work during other months. Yet, their monthly payment remains the same as long as the required service levels are maintained, which ensures the quality of works under PBMC [7].

The road authority has the option for the possibility of long-term sustainability in the management system using PBMC. Due to its longevity, staffs are able to understand a network and have the time to implement initiatives based on this knowledge, as well as understanding which areas of the network are under stress and how these areas are likely to react to extreme events [8].

The contractors receive flexibility in achieving their work target under PBMC. Lancelot [9] indicated in regard to the CREMA (PBMC) experience in Brazil that is under performance based contracts, contractors needed to have sufficient flexibility to determine an optimized mix of technical solutions and an optimized execution schedule, without any interference from the employer.

PBMC has the potential to reduce the scale of the decision making process by promoting transparency and good governance in road maintenance works [3, 10].

The road authorities should consider the issues discussed in the next section to achieve the benefits of PBMC.

IV. ISSUES TO BE CONSIDERED BEFORE INTRODUCTION OF PBMC

The use of PBMC is becoming popular and many road authorities are trying to introduce PBMC in their countries. A Pilot trial project of PBMC is needed before it is fully introduced to measure the feasibility, capability, cost and quality of work and establish a relationship between the contractor or private sector and the road authority [11]. The road authority should try to address these needs during the pilot trial. Moreover, the literature review and analysis of this research has identified a number of common issues that have been considered by several road authorities before the introduction of PBMC. The issues are as follows: Performance specification and Set up a Standard, Expertise of the private sector, Deciding the initial project, Risk exposures, Employee

issues, Performance Monitoring, Payment and termination of the contract. Road authorities should also consider these issues so that they can successfully introduce and implement PBMC.

A. Performance specification and Set up a Standard

Performance-based maintenance contracts are designed to manage the performance of contractors and gain the assurance of quality road maintenance works [12]. The road authority is responsible for determining the quantity, type and location of the work outputs required to achieve the desired performance levels in PBMC [11]. However, setting up a performance standard is very important to measure the contractor's quality of work and for payment purposes. Performance standards also guide the contractors to render the desired result; however, the contractors select the manner in which the work is to be performed [12]. Performance standards have to be clearly defined in the contract and objectively measurable to avoid ambiguity. A Highway Design Model (HDM) can also be used to set up parameters, for example, International Roughness Index [1]. The application of a minimum acceptable level of performance can be achieved through the implementation of targets based on performance standards [13]. Table 1 presents some typical performance standards and their influence on roads [1].

TABLE I
TYPICAL PERFORMANCE STANDARDS AND THEIR INFLUENCE ON ROADS [1].

Performance Standards	Influence
International Roughness Index (IRI) to measure the roughness of the road surface.	Vehicle operating cost
1. Absence of potholes. 2. Control of cracks and rutting.	Road safety and pavement performance
The minimum amount of friction between tires and the road surface	Road safety
The maximum amount of siltation or other obstruction of the drainage system.	To avoid destruction of the road structure
The retro reflexivity of road signs and markings.	Road safety

The literature review of this research found that the cost of road maintenance may vary depending on the road sections, traffic condition of the roads and the environment of the country. It is important to set up the performance standard taking into account the past record of the roads.

B. Expertise of the private sector

As PBMC is a new concept, it requires experienced private sector or large contractor to take such responsibilities. Many road authorities have taken help from internationally experienced contractors and organizations in order to train their own staff and contractors. The maintenance and rehabilitation work of roads should be separately identified for the pilot trial of PBMC depending on the capability of the road authority. It may help the road authority and the contractor to gain experience on the new approach.

The framework document on introduction of PBMC in Indonesia revealed that contractors were capable of handling large contract with risk sharing responsibility, but they required training on maintenance management [14]. Before contracting out the large proportion of the arterial road network of Sydney, New South Wales, Australia in 1995, the Road Transport Authority (RTA) of New South Wales developed a pilot project in 1990. They recognized that the establishment of a performance based contract would require a good register of asset extent and condition, information on historical work outputs and a methodology for the objective measurement and reporting of asset performance. As these factors were not adequately addressed at that time, and due to the risk factors, the RTA elected to adopt a more conventional style of contract. The conventional approach also gave the RTA more control over the day-to-day activities of the contractor and this was of comfort to the RTA during the pilot phase [11].

Introduction process of PBMC (CREMA) approach in Brazil can also be given as an example. The implementation of this revolutionary approach in the Brazilian context required important efforts of adaptation on both the public/client and private/contractor sides. Such adaptation took place in a gradual fashion, with a relatively lengthy process (close to a year) to structure the first bidding documents and related technical norms. At bidding stage, the private sector reaction to CREMA in the state of Rio Grande do Sul was adequate. On the other hand, reaction in a first round of bidding at the federal level was less successful and inadequate proposals warranted the re-bidding of the first CREMA contracts [9].

This research found that the long term performance-based maintenance contracts requires a proper planning and timing among the road authority and the private sector or contractor to gain experience and fulfill its objective of achieving a strong and cost-effective road infrastructure system.

C. Deciding the initial project

The road authority has to decide the type of the road and the duration of the contract which will perform better under PBMC at its initial stage. Stankevich, et al. [4] said that the level of complexity of a PBMC can range from "simple" to "comprehensive" depending on the number of assets and range of services included. A simple PBMC would cover a single service (for example, only mowing, only street light maintenance) and could be awarded for relatively short periods (several months or one year). A comprehensive PBMC would typically cover all road assets with the right-of-way and comprise the full range of services needed to manage and maintain the contracted road corridor. Such services would include routine maintenance, periodic maintenance and traffic accident assistance. As periodic maintenance works (for example, 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. In a comprehensive PBMC, most of the works are often outsourced by the main contractor to subcontractors. Rehabilitation is not a compulsory

component of a comprehensive PBMC. Many road agencies include rehabilitation as a part of PBMC; others choose to handle rehabilitation using traditional methods of contracting. Anastasopoulos, et al. [15] said that projects with strong competition, long duration and extension periods, long outsourced road sections, that incorporate crack sealing, pothole repair, illumination repair/maintenance, and mowing activities, perform better under PBMC. After the execution of the first PBMC (CREMA) in Brazil, the state of Rio Grande do Sul and the federal level revealed a number of weaknesses, which have been gradually corrected in follow-up CREMA contracts. The overall process of preparation, bidding and execution of the first CREMA contracts resulted in a number of valuable lessons, which were taken into account in structuring and bidding further performance based contracts in Brazil [9].

The analysis of this research suggests that during the selection of the pilot project a road authority should consider the type and length of roads and duration of the contract. The length of PBMC can vary from 2 to 10 years. Failure in first trial refrain the road authority to proceed further with the new concept. However, road authorities can learn from the first contract and use the lessons to improve the future contracts.

D. Risk exposures

A shift in the method of specification, from work output to performance, will shift the risk exposure of the road authority to the contractor. The fundamental premise of the first PBMC by RTA of New South Wales, Australia was that the contractor had to achieve the specified road condition standards over the term of the contract and must program, fund, design and deliver whatever works are required to achieve these standards [11]. The risks for which the RTA continued to bear some responsibility in that contract were as follows:

- Major bridge repair activities such as strengthening, rehabilitation and replacement and major embankment repair activity.
- Force Majeure includes events such as earthquake, bushfire, extreme weather or flood, war, riot, blockades and contamination. The basic definition is that Force Majeure applies for events which could not have been reasonably predicted, are beyond the control and could not have been avoided by the road authority and the contractor.
- Changes in traffic volume and in inventory.
- Exclusion of two low trafficked roads in poor condition.
- Reimbursement of costs arising from the defined third party actions such as the restoration of road excavations by others (water, gas, telephone etc), damage due to an over-dimensioned vehicle operating under permit, damage due to a motor vehicle accident, vandalism, excluding graffiti [11].

Some literature also suggested that PBMC may include risks like poor quality of construction, unexpectedly severe weather, unanticipated environmental problems, emergencies, unanticipated legislative change, unexpected traffic growth, a short-term focus that fails to minimize long-term life-cycle

costs, and difficulty in acquiring the resources needed to perform the work (for example, subcontractors) [16]. However, the risk allocation to the contractor would be beneficial for the road authority only when a contractor would better be able to manage the risk [17, 18].

This research suggests that the risk exposure issue should be properly identified and addressed to the contractors who want to participate in the tendering stage during the introduction of PBMC. However, individual road authorities should consider to what extent they can share and manage the risk.

E. Performance Monitoring

Monitoring the performance of the contractor is another important part of PBMC. Moreover, the road authorities should always try to keep pace with the advancement of innovative technology, and increasing expectation of road users with time. Road authorities are required to monitor the quality of work, record the cost savings and the road history and inventory data for future research and development during the implementation of PBMC.

The monitoring system may differ among the road authorities. Zietlow [19] added that the monitoring system may include contractors' self control system, formal monthly inspections and informal inspections by the road authority, and road users' complaint system. As PBMC are relatively new concept, the availability of reliable and comprehensive set of guidelines to evaluate the effectiveness and efficiency of this type of contract is limited. Many road authorities currently rely on the criteria and procedures developed for their traditional methods of contracting to evaluate the performance of contractors in maintaining roads [20]. These standards vary significantly among the road authorities and some of them have not been properly defined to monitor PBMC. de la Garza, et al. [20] identified five components in order to develop a framework for monitoring the performance in PBMC. The components are as follows: Level of Service Effectiveness, Timeliness of Response, Safety Procedures, Quality of Services, and Cost-Efficiency.

Level of Service Effectiveness indicates the extent to which the performance criteria and performance targets defined in the contract are being met.

Timeliness of Response evaluates the response time of the contractor to service requests related to events or deficient elements in the roadway that need to be attended in a timely manner.

Safety Procedures evaluates if a safety program is properly implemented by the contractor. This component is very important to ensure that the road users as well as the maintenance crews performing the work are exposed to minimum risk of accidents.

Quality of Services assesses the customer perceptions with respect to the condition of the assets and contractor performance. Customers are the ultimate evaluators of the quality of the service provided; therefore, it is extremely important to assess their satisfaction.

Cost-Efficiency assesses the cost savings, if any, accrued by the government as a result of engaging a contractor to perform performance-based road maintenance services [20].

F. Employee Issue

In Estonia, where 63% of the national road network is under PBMC, the workforce of the national and sub-national road agencies has declined, specifically from 2,046 (administration staff-561, workers-1,485) in 1999 to 692 employees (administration staff -343, workers -349) in 2003 [4]. As the road authority requires less people for administrative work and supervision in PBMC, the fear for losing job is an important issue for the employees and the road authority. In many contracts, private operators retain the existing employees because of the benefits of having an experienced workforce [12].

Prior to the establishment of PBMC, the Road Transport Authority (RTA) of New South Wales, Australia employed 89 people on works which would be included in the contract. The contracting company's offer included a provision for their employment of up to 35 of these people, based on the contractor's satisfaction on their suitability and willingness of these employees to work with the contractor. The negotiations between the RTA and unions focused on arrangements for dealing with the affected staff, the nature of any redundancy payout package, and the number of staff affected and/or to be taken by the contractor. Finally, the RTA transferred 44 of the affected staff to other duties within the RTA and gave voluntary redundancy packages to a further 40 employees. Only 5 staff took up the offer of employment by the contracting company [11].

This research suggests that the road authority should carefully consider the employee issue during the introduction of PBMC. They should prepare a plan for the staff that is losing the jobs if they want to achieve the success in implementing PBMC. On the other hand, cut down of staff should not be so extreme that the road authority loses the capability of undertaking future research for the improvement of the work.

G. Payment and termination of the contract

The compensation package and payment schedule should also be incorporated into the contract. Payments of performance-based contracts should be the part of the package and will be a bit more complex than standard fixed-price payment schedules. One strategy is to structure the compensation in two parts. First, a fixed fee designed to cover basic facility operating costs and any maintenance and capital upgrades must be agreed upon. Second, a variable fee tied to performance against a basket of outcome measures may be developed [12].

A "must" section details the method of termination for non-compliance, non-performance, or general breach of a contract. It can be helpful to establish an escalating scale of specific sanctions that culminate in termination and to specify the use and structure of arbitration or mediation. Often, contracts will

include "termination for convenience" clauses, which allow either party to end the agreement without cause but requiring sufficient notice, usually 60 to 120 days [12].

The cost of tendering and bidding in PBMC is very high. It is necessary to have clearly defined contract documents to resolve any problem regarding the poor performance of contractors which can lead to the termination of the contract especially during the initial stage of implementing PBMC in a country.

V. SOME SPECIAL ISSUES FOR DEVELOPING COUNTRIES

The issues discussed earlier are common for developed and developing countries. The analysis of this research has identified some other issues which need special concern during the implementation of PBMC in a developing country. This section presents a brief discussion of these issues. The issues are as follows: Political influence, Corruption, Securing the source of long-term funding, and Estimating the cost of PBMC.

Influence of Political leaders and parties in the road sector is a serious concern for developing countries. One of the objectives of introducing PBMC for road infrastructure maintenance is to reduce the chance of political influence and corruption. Performance of contractors is supervised by the road authority in PBMC. The survey of this research suggests that the supervision work should be free from corruption. Moreover, the road authority of a developing country should also ensure that the selection of contractors will be free from political influence. This issue is not a concern in developed countries as their road authorities are always keen to ensure road users satisfaction and return the tax payers money in the form of safe and secure roads.

Many developing countries have received support and loan from international organizations during the implementation of PBMC. This research suggests that the road authority should not depend only on the external support. They should try to manage and plan internal funding for the long term PBMC as early as possible.

The road authorities in developing countries may face problems in estimating the cost of PBMC due to lack of past history and data on roads. They should prepare a long term planning before introducing PBMC such as: starting the project with the roads for which data and history are available and in the mean time collecting data on future projects, consulting with consultants experienced in PBMC and doing research in similar contracts in other developing countries.

VI. CONCLUSION

A well-established road infrastructure system for communication is the prerequisite to maintain a sustainable socio-economic structure. PBMC is a new concept to resolve the problems related to traditional methods of contracting and has significant potential to improve the maintenance and management of road infrastructure system. Developed countries including USA, Australia, New Zealand, and UK

have implemented PBMC successfully. Many developing countries have already implemented PBMC, where some other countries are currently considering PBMC for their road infrastructure systems. This paper reviewed and analyzed a large number of published information and literature to present an overview of the potential issues to be considered before the introduction of PBMC in a country. The content of this paper will be beneficial to the road authorities who are currently considering introducing PBMC.

This concept is still in its early stage and has huge potential and scope of work for future researchers. The potential of reducing maintenance costs, increasing the quality of works and reducing the chance of political influence and corruption in developing countries are the challenging issues for PBMC, which needs more attention. Further research can be carried out on performance standards in different countries, and to develop a model which can help the road authority to plan a proper performance-based maintenance contract and save costs of road maintenance works.

REFERENCES

- [1] G. J. Zietlow, "Cutting Costs and Improving Quality through Performance-Based Road Management and Maintenance Contracts-The Latin American and OECD Experiences," presented at the Senior Road Executives Programme, Restructuring Road Management, German Development Cooperation, Birmingham, U.K., 2005.
- [2] M. Frost and C. M. Lithgow, "Future Trends in Performance-Based Contracting- Legal and Technical perspectives," in *IIR conference*, Sydney, Australia., 1998.
- [3] G. J. Zietlow, "Implementing Performance-Based Road Management and Maintenance Contracts in Developing Countries, An instrument of German Development Cooperation, Birmingham, U.K., ed. Birmingham., 2004.
- [4] N. Stankevich, N. Qureshi, and C. Queiroz, "Performance-based Contracting for Preservation and Improvement of Road Assets," The World Bank, Washington, DC 2005.
- [5] A. Straub, "Cost Savings from Performance-Based Maintenance Contracting," *International Journal of Strategic Property Management*, vol. 13, pp. 205-217, 2009.
- [6] B. Carpenter, E. Fekpe, and D. Gopalakrishna, "Performance-Based Contracting for the Highway Construction Industry, An Evaluation of the Use of Innovative Contracting and Performance Specification in Highway Construction," Koch Industries Inc., Washington, D.C. February 2003.
- [7] The World Bank, "Design and procurement of long-term pilot contracts for the performance-based management and Maintenance of roads (output based Approach)," World Bank, Washington D.C. 2004.
- [8] M. Keir and G. V. Blerk, "A Review of the Performance Specified Maintenance Contract (PSMC) Model Using a Case Study of PSMC 001, Case Study- Transit New Zealand," Transfield Services 2006.
- [9] E. Lancelot, "Performance Based Contracts in the Road Sector: Towards Improved Efficiency in the Management of Maintenance and Rehabilitation Brazil's Experience," The World Bank Group., Washinton D.C. 2010.
- [10] G. Liautaud, *Maintaining Roads: Experience with Output-Based Contracts in Argentina Chapter 4, Contracting for Public Services, Output-Based Aid and its Applications*, . Washington D.C.: World Bank, 2001.
- [11] M. Frost and C. Lithgow, "Improving Quality and Cutting Costs Through Performance Contracts-Australian Experience," in *World Bank Road Management Training Seminar*, Washington DC, USA, 1996.
- [12] G. F. Segal, A. T. Moore, and S. McCarthy, "Contracting For Road and Highway Maintenance," Reason Foundation, Reason Public Policy Institute 2003.
- [13] R. Haas, G. Felio, Z. Lounis, and L. C. Falls, "Measurable performance indicators for roads: Canadian and International Practice," presented at

- the Best Practices in Urban Transportation Planning: Measuring Change, Vancouver, British Columbia, 2009.
- [14] Opus International Consultants Ltd, "Introducing Performance Based Maintenance Contracts to Indonesia Framework Document," MWH NZ Limited 2006.
 - [15] P. C. Anastasopoulos, B. G. McCullough, K. Gkritza, F. L. Mannering, and K. C. Sinha, "A Cost Savings Analysis of Performance-Based Contracts for Highway Maintenance Operations " *Journal of Infrastructure Systems*, ASCE, vol. 16, pp. 251-263, 2010.
 - [16] W. A. Hyman, AASHTO, and Federal Highway Administration, *Performance-based contracting for maintenance, A Synthesis of Highway Practice, NCHRP Synthesis 389*. Washington, D.C.: Transportation Research Board, 2009.
 - [17] P. Hardy, "Austroads Review of Performance Contracts: The Potential Benefits of Performance Contracts," Opus International Consultants, Nelson 2001.
 - [18] Austroads Inc., "Development of Performance Contracts and specifications - Full report, Opus International Consultants, New Zealand," 0 85588 670 6, 2003.
 - [19] G. J. Zietlow, "Performance-Based Road Management and Maintenance Contracts-Worldwide Experiences," in *International Seminar on Road Financing and Investment*, Arusha, Tanzania, 2007.
 - [20] J. M. de la Garza, J. C. Pinero, and M. E. Ozbek, "A Framework for Monitoring Performance-Based Road Maintenance Contracts," in *Proceedings of the Associated Schools of Construction 45th Annual International Conference*, , Gainesville, FL., 2009, pp. 433-441.