

Performance-Based Contracting for Maintenance

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP SYNTHESIS 389

**Performance-Based Contracting for
Maintenance**

A Synthesis of Highway Practice

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SUBJECT AREAS

Maintenance

Research Sponsored by the American Association of State Highway and Transportation Officials
in Cooperation with the Federal Highway Administration

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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The principal author of the synthesis study was William A. Hyman, who began the project as principal engineering economist at Applied Research Associates, Inc. Richard Speir, manager of the Mid-Atlantic Division of Applied Research Associates, provided quality reviews and project oversight. Hamid Shirazi assisted in writing part of the literature review. A number of panel members helped increase survey response rates, made brief written contributions reflecting specific perspectives, or arranged

for discussions with individuals knowledgeable about the details of a specific maintenance contract. Others who provided significant input included Jennifer Brandenburg of the North Carolina Department of Transportation (DOT), Chris Christopher of Washington State DOT, Tom Raught and Jeff Lowry of New Mexico DOT, and Sharon Holmes, formerly of Florida DOT. Cynthia Stancil, office administrator, compiled the survey results and helped prepare other material for incorporation into the synthesis report.

FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, “Synthesis of Information Related to Highway Problems,” searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

*By Jon Williams
Program Director
Transportation
Research Board*

Performance-Based Maintenance Contracting (PBMC) provides incentives and disincentives to achieve desired outcomes or results from the maintenance contractor. This is distinct from the more usual practice for highway maintenance contracting—low bid combined with method specification. This report explores experience with PBMC in places where it has been adopted, including such issues as whether it has the potential to reduce costs and improve maintenance levels of service. Methods for implementing PBMC are also discussed. The report is likely to be useful for those agencies who are evaluating whether to include PBMC in their highway maintenance program.

Information for this study was gathered by literature review of international experience, domestic U.S. state experience, federal government experience, and warranty contracts, as well as surveys conducted of state transportation agencies, Canadian provincial agencies, and a sampling of private firms. The surveys were augmented with individual interviews.

William A. Hyman, formerly with Applied Research Associates, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

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PERFORMANCE-BASED CONTRACTING FOR MAINTENANCE

SUMMARY Performance-Based Maintenance Contracting (PBMC) was first implemented on a wide scale in British Columbia and since then has become a mainstay of maintenance contracting in Australia, New Zealand, England, and Finland, and to an increasing degree in other countries, including the United States. State leaders in this area include Virginia, Texas, and Florida.

Not every state and every country is able to or desires to pursue PBMC. The reasons include adequate capacity of the in-house staff to perform most maintenance, lack of statutory authority, and disappointing experience with the approach in the past. Some transportation agencies in North America, however, have adopted PBMC to complement their traditional approach to maintenance contracting.

State and provincial transportation agencies are faced with growing needs and limited resources to maintain the highway network. The resulting challenges have motivated these agencies to expand the amount of contracting they do. Moreover, transportation agencies both in North America and around the world have developed a variety of methods for undertaking PBMC, known by other names such as Total Asset Management and Performance-Specified Maintenance Contracts.

The report discusses the following fundamental issues:

- Reasons for doing or not doing PBMC;
- Whether PBMC results in value for money;
- The challenges in determining changes in levels of service and costs;
- Allocation of risks;
- The basic steps for undertaking a performance-based maintenance contract;
- Types of contracts;
- Performance measures and considerations in setting performance standards, incentives, and disincentives;
- Contractor selection criteria;
- Options for monitoring contractors;
- Working effectively with unions;
- Partnering; and
- Training.

A literature search on PBMC was one of the two primary sources of material for this synthesis. The literature is examined from four viewpoints: international experience, domestic experience, warranty contracts, and performance-based contracting in the federal government.

Surveys were the other primary source of input to the synthesis. One survey was administered to all state departments of transportation (DOTs), the District of Columbia, and Canadian provincial transportation agencies. Seventy-five percent of the states and the District of Columbia responded. The combined response rate of the states, the District of

Columbia, and the provincial transportation agencies was 69%. This survey yielded a wealth of information. Another survey was sent to private firms engaged in PBMC. These firms were asked to complete the survey with the understanding that their answers would remain confidential and could not be identified with a firm. Four private firms that perform PBMC made a number of valuable remarks that could be useful for transportation agencies crafting or modifying performance-based maintenance contracts.

Among the most important conclusions of the study are the following:

- The use of PBMC is accelerating worldwide. By 2005, 35 countries had performance-based maintenance contracts. By early 2006, approximately 15 more were exploring or adopting this approach to maintenance.
- In the United States and Canada there are already many examples of PBMC. States, provinces, and other entities that have been leaders include Virginia, Texas, Florida, the District of Columbia, British Columbia, Alberta, and Ontario.
- PBMC reflects a long-term trend in changing the focus of upper management and maintenance managers to outcomes, especially those that are customer oriented.
- There is evidence that PBMC results in better outcomes at lower cost with less risk and more financial predictability for highway agencies.
- The evidence on whether PBMC results in improved levels of service is not consistent. In some cases, particularly those in which asset condition or the quality of service are low or have been allowed to deteriorate a great deal, PBMC has resulted in a sharp increase in levels of service. Also, there are other reported improvements in levels of service resulting from PBMC. However, one state and two Canadian provinces, where a large amount of PBMC occurs, do not separate the outcomes achieved by in-house staff and private contractors and the levels of service of contractors cannot be verified. Sometimes levels of service may decline at first. Texas DOT observed this pattern on two interstate performance-based maintenance contracts.
- A number of agencies are skeptical regarding the claims of cost savings, even though studies provide evidence that cost savings exist. These agencies question—as have a number of internal and external audits regarding specific contracts or programs—whether a valid basis exists for cost comparisons between force account work and PBMC by private firms. Issues about making cost comparisons are complex. For example, it is not easy to develop accurate comparisons that place both direct and indirect costs of public agencies and private firms on an equal footing.
- PBMC, despite the success touted by its advocates, is controversial. There is a risk that a large part of the maintenance organization of a transportation agency will be privatized. As a result, a large number of public employees might have to seek employment with contractors if they wish to continue doing similar work. In-house maintenance staff becomes unsettled with the potential loss of worker protection and the possibility of reduced pay or benefits.
- The most frequent approach to payment in PBMC is a lump-sum with deductions for failing to meet performance standards. The literature and responses to the surveys suggest that a more balanced approach, including both incentives and disincentives, is a better approach and enhances partnering.
- Successful partnering appears to be critical to the success of PBMC.
- PBMC is more likely to succeed when the contracting agency and the contractor both share risks and rewards.
- Many performance-based maintenance contracts are hybrids and include performance and method specifications, payments based on both lump-sum and unit prices, maintenance and rehabilitation work, and different phases of a facility life-cycle, such as design, build, operate, and maintain.
- Training has an essential role to play on the part of the contracting agency, the contractor, and any independent third party responsible for evaluating the performance of the contractor.

The following suggestions for future research are offered:

- Research could be conducted to explore performance measures and measurement protocols concerning levels of service for different types of maintenance assets and operations.
- Research is needed on defensible methodologies for evaluating cost savings of performance-based contracting. This research could include an analysis of administrative savings.
- Further investigation regarding the impacts of PBMC on agency staff and how to mitigate adverse effects is desirable. The impacts will vary depending on the percent of maintenance work contracted out under PBMC, whether maintenance is completely privatized, whether there is public–private competition, the size and nature of the contracting community, and the management and organizational structure used.
- More research is required on how to implement an effective benchmarking process that can be used to compare agency and contractor performance (outcomes and outputs relative to costs with adjustments for uncontrollable factors), identify best performers, and determine the corresponding best practices. This would be a follow-up study to the 2005 *NCHRP Report 511: Guide for Customer-Driven Benchmarking of Maintenance Activities*.
- The maintenance community in the United States and Canada would benefit from a set of model procurement documents and contracts. PBMC is continually evolving and thus these model documents would need to be updated from time to time.
- Training programs would be useful for PBMC. A variety of audiences and formats could be addressed, including maintenance organizations of transportation agencies, contractors, subcontractors, in-house staff and contractors working together, and contractor/subcontractor interaction.

CHAPTER ONE

INTRODUCTION**PERFORMANCE-BASED MAINTENANCE CONTRACTING**

Performance-Based Maintenance Contracting (PBMC) is a contracting method that provides incentives and/or disincentives to the contractor to achieve desired outcomes or results; in its purest form, PBMC does not detail how, when, or where to do the work.

In the highway arena, where low-bid contracting combined with method specifications has been the norm for most of the twentieth century, PBMC represents a departure from standard practice. Based on increasing experience with PBMC both in the United States and around the world, PBMC has much to recommend it. This approach to contracting is not a panacea, it is not universally accepted, and failure has occurred. However, transportation agencies see it as an important option to consider and a valuable or potential instrument in their contracting tool kit. This synthesis study offers managers of departments of transportation (DOTs) and maintenance programs information on the state-of-the-practice regarding PBMC in the United States and abroad and provides several case studies and information about PBMC. This information could allow managers and practitioners to make more informed decisions regarding whether to pursue PBMC in specific instances.

PROBLEM WORK STATEMENT AND SCOPE OF WORK

This NCHRP synthesis topic, “Performance-Based Contracting for Maintenance,” was motivated by the following problem statement:

State Departments of Transportation (DOTs) are confronted with both growing needs and resource limitations for maintaining the highway system. This has intensified their interest in contracting maintenance services. Transportation agencies have developed various performance-based contracting methods, including the means to measure and report on performance. The purpose of this synthesis is to obtain information on implementation of performance-based contracting.

The scope of work called for investigating a number of topics. Agencies currently engaged in or contemplating doing PBMC in the future need information on the basic ele-

ments to initiate performance-based maintenance delivery. These include an effective contractor acquisition strategy, prequalification processes, criteria for selecting a contractor, and criteria for assessing contractor performance. Contractual provisions such as payment methods, including incentives and disincentives, need to be identified. PBMC relies on identifying performance measures, establishing desired performance standards or targets, and measuring the levels of service (LOS) achieved. It is important to document such measures and standards commonly used in PBMC for different types of maintenance activities. Agency experience with PBMC varies. It is important that the reported costs, benefits, risks, and possible shortcomings of adopting PBMC be explored.

REPORT APPROACH

NCHRP synthesis projects are intended to provide a synthesis of the state of the practice on a particular topic. The primary motivation is to provide the means, through a synthesis report, to allow transportation agencies to share information about their practices.

In this NCHRP synthesis project, two primary sources of information were used to prepare the synthesis report; one or more surveys or questionnaires and a literature search.

In this report on PBMC, surveys were administered to 50 state transportation departments, the District of Columbia Department of Public Works, and to the 10 Canadian provincial transportation agencies. Surveys were administered to private firms engaged in PBMC in the United States or Canada. Table 1 shows the number of surveys sent out and returned.

To reduce nonresponse bias, an objective was to achieve a response rate of roughly 80% from state DOTs. The response rate from state DOTs and the District of Columbia was 38 of 51 or 75%. The response rate from all transportation agencies in the United States and Canada that were surveyed was 42 of 61 or 69%. The response rate from private contractors was 4 of 14 or 29%.

The literature search drew on many sources, including the following:

TABLE 1
SURVEYS DISTRIBUTED AND RETURNED

Surveys	No.
Distributed to states, the District of Columbia, and provincial agencies	61
Returned by states and the District of Columbia	38
Returned by provincial transportation agencies	4
Distributed to private contractors	14
Returned by private contractors	4

- Prior studies on performance-based contracting
- Primary documents concerning specific performance-based maintenance contracts and corresponding experience
- The Internet site on PBMC practices around the world established and maintained by Gunter Zietlow (Zietlow 2005b)
- A search of citations and abstracts found in the TRB's Transportation Research Information Service
- Library materials found in the collections of the TRB library
- A World Bank CD-ROM containing information on PBMC experiences in many countries, including the United States and Canada
- Guidance on performance-based contracting found on the Internet, such as "Seven Steps to Performance-Based Service Acquisition," developed for federal agencies
- Numerous Internet searches on various topics concerning PBMC
- The author's library on maintenance and operations management
- Information provided by panel members.

There are approximately five layers to the literature on PBMC:

- Broad overviews of PBMC
- Studies of PBMC in specific countries, states, provinces, cities, or counties
- Papers and presentations that provide a general review of a specific contract or instance of PBMC
- Detailed independent evaluations, legislative audits, and critical reviews
- Reports or internal memoranda containing primary or raw data concerning cost savings, productivity, and effectiveness (these include before-and-after studies; cost and outcome studies of maintenance work performed by in-house staff versus PBMC; and cost and outcome studies of method-based contracting versus PBMC).

In many cases, the more deeply one digs into the literature, the more the facts become unclear. Sorting the facts out—including addressing ambiguity, gauging uncertainty, untangling controversy, and establishing defensible results—quantitative or qualitative—is often challenging.

Although the surveys and literature search are the primary sources for the synthesis study, the panel, which includes experts on various topics related to PBMC, provided considerable feedback. The panel members provided general and specific direction on the conduct of the report, including report organization and content. Frequently, based on panel members' experience, they were able to provide substantive input, both in terms of guidance and source material. One panel member authored a couple pages to ensure that a specific perspective was addressed and to provide balance in the presentation.

KEY ISSUES

PBMC poses many challenges to those accustomed to standard procurement procedures such as low bid, best value, and qualifications-based selection, or even more complicated procurements involving toll road concessions, design-build-operate and maintain, and public-private partnerships involving PBMC. The maintenance community in the United States may be witnessing the beginning of a sea change in maintenance contracting. At a minimum, maintenance managers need good answers to the following questions:

- Does the growing number of transportation agencies in the United States, Canada, and abroad doing PBMC suggest that there is a compelling reason for agencies not currently doing PBMC to consider it or try it?
- On balance, is the experience of agencies with PBMC successful, unsuccessful, or mixed?
- Does PBMC lead to cost savings?
- How likely is PBMC to result in higher LOS at the same or lower costs?
- How should the in-house maintenance workforce adapt to PBMC in light of possible significant cultural or even organizational changes?
- How does one manage the significant cultural changes usually required to make PBMC successful?
- Is PBMC an effective method of shifting risks to the contractors?
- How imperative is it that transportation agencies and contractors share risks?
- Can DOTs achieve expenditure stability for maintenance using PBMC?
- What types of measures and performance standards or targets are desirable to include in a performance-based maintenance contract?
- Do contracting agencies rely only on performance specifications in PBMC, or do they continue to

include method specifications? Do they use hybrid approaches?

- How can the partnering process between the contracting agency and the contractor be most effective?
- What are the training needs for PBMC?
- What is an effective contractor acquisition process?
- How important is it for transportation agencies to document their inventory and condition of maintenance assets?
- What contractor prequalification procedures make the most sense?
- What selection criteria are commonly used for PBMC? Do some states have constraints on award criteria?
- What are the options for monitoring the performance of contractors and what is the best approach?

ORGANIZATION OF REPORT

This synthesis report is organized as follows:

- Chapter one sets out the scope of work, the report approach, and key issues regarding PBMC.
- Chapter two provides an indication of how much PBMC is occurring in the United States and other countries

and discusses key issues in PBMC, including reasons for doing or not doing PBMC, challenges in determining whether PBMC results in value for money, types of contracts, incentives and disincentives, risk allocation, and partnering.

- Chapter three includes a literature review that focuses on four areas: domestic experience mainly at the state level, international experience, federal experience, and the basic steps of PBMC.
- Chapter four presents the survey results from state and provincial transportation agencies as well as contractors.
- Chapter five draws conclusions based on the information acquired for this synthesis study. Suggestions for future research also appear here.

The reports concludes with references, a bibliography, a list of abbreviations, a glossary, and a series of appendixes consisting of the following: sample survey documents; Internet sites containing sample procurement documents and contracts; information on LOS and cost savings from PBMC in different states, provinces, and countries; and a comparison of performance measures distributed at the AASHTO Performance-Based Maintenance Contract and Peer Exchange in San Antonio, Texas, March 20–21, 2007.

CHAPTER TWO

OVERVIEW OF PERFORMANCE-BASED MAINTENANCE CONTRACTING**WHAT IS PERFORMANCE-BASED MAINTENANCE CONTRACTING?**

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

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

There are many names for PBMC used around the world and within certain states or provinces including:

- Performance-Based Maintenance Contract (United States)
- Performance Contract (Western Australia)
- Total Maintenance Contract (Texas)
- Performance-Specified Maintenance Contract (Australia and New Zealand)
- Asset Management Contract (originally more common abroad, but this term now used in the United States)
- Contract for Rehabilitation and Maintenance (Argentina)
- Managing Agent Contract (United Kingdom)
- Area Maintenance Contract (Finland and Ontario, Canada).

BRIEF OVERVIEW OF U.S. EXPERIENCE

There were a variety of early efforts to pursue PBMC in the United States. These included a performance-based maintenance

contract in California for public streets in the late 1970s and a pilot for the Pennsylvania Department of Transportation (DOT) in the early 1980s. Lawyers stopped the California effort, and union and tort liability issues brought the Pennsylvania DOT effort to a halt (A5T60 Task Force 2004).

More recently Virginia, Texas, and Florida have used PBMC on a large scale, including fence-to-fence maintenance contracts on Interstate highways. Texas and Florida have used PBMC for rest area contracts and the Maryland State Highway Administration (SHA) recently did as well. The District of Columbia entered into a performance-based maintenance contract for 75 miles of the National Highway System (NHS) within its jurisdiction (Stankevich et al. 2006).

The Oklahoma DOT sought to implement PBMC in five counties encompassing Tulsa and Oklahoma City. However, a dispute arose (Hill et al. 2007). New Mexico entered into a performance-based warranty contract on State Route 44 (renamed US-550). The contractor failed to deliver to New Mexico a quality product and was required to repair the highway under the warranty provisions (Lowry 2007).

Table 2 shows the states and provinces that have tried or are currently doing PBMC among those who responded to the survey administered for this synthesis project. The information in this table says nothing about each agency's experience with PBMC. As noted previously, some states have had considerable success with the approach. The experience of some was not so positive. Others are getting their feet wet and have not seen a contract to the completion of its term. Note that Wisconsin contracts with all of its counties. Although the contracts do not mandate PBMC, they include a clause that allows reimbursement of the costs of the county maintenance managers to partner with state regional managers and conduct performance evaluations of randomly selected road sections (A. Lebwohl, personal communication, 2007).

BRIEF OVERVIEW OF INTERNATIONAL EXPERIENCE

In 1988, the British Columbia Ministry of Transportation conducted a pilot performance-based maintenance contract. The provinces of Ontario and Alberta followed suit with performance-based contracts of their own (Stankevich et al. 2005). New Brunswick indicated in its survey response that

it does use PBMC; Manitoba and Nova Scotia said they do not (see Table 3).

TABLE 2
STATE AGENCIES THAT DO PBMC BASED ON SURVEY RESPONSES

State	Yes	No
Arizona		X
Arkansas		X
California		X
Colorado		X
Connecticut		X
Delaware		X
District of Columbia	X	
Florida	X	
Hawaii		X
Illinois		X
Iowa		X
Idaho	X	
Kansas		X
Louisiana		X
Maryland	X	
Michigan		X
Minnesota		X
Mississippi		X
Missouri		X
Nebraska		X
Nevada		X
New Hampshire		X
New Mexico	X	
New York		X
North Carolina		X
North Dakota		X
Ohio		X
Oklahoma		X
South Carolina		X
South Dakota		X
Tennessee		X
Texas	X	
Utah	X	
Vermont		X
Virginia	X	
Washington		X
West Virginia		X
Wisconsin		X

TABLE 3
CANADIAN PROVINCES THAT DO PBMC BASED ON SURVEY RESPONSES

Canadian Province	Yes	No
Ontario	X	
New Brunswick	X	
Manitoba		X
Nova Scotia		X

PBMC has become widespread in South America. The first major performance-based maintenance contract occurred in Argentina in 1995 and is known as *Contrato de REcuperacion y MAntenimiento* (CREMA), which means Contract for Rehabilitation and Maintenance. The initial CREMA was structured to first rehabilitate part of the network; simultaneously, maintenance under performance-based specifications began on the other sections of the network under the CREMA contract and then was expanded to the rehabilitated sections of road. Today, performance-based maintenance contracts cover 44% of Argentina's roadway network. Based on Argentina's success, Uruguay followed suit and so did the city of Montevideo on its main city streets. Other Latin American countries have followed Argentina's and Uruguay's lead and adopted or have begun to adopt some form of PBMC. These include Brazil, Chile, Columbia, Ecuador, Guatemala, Mexico, and Peru (Stankevich et al. 2005).

PBMC has been prominently used in Australia, New Zealand, England, and Finland. Sydney, Australia, sought to use PBMC to maintain its city roads beginning in 1995. Subsequently, New South Wales, Tasmania, and Southern and Western Australia have used performance-based and hybrid contracts (Pakkala et al. 2007).

The use of PBMC is accelerating throughout the world. The following countries are also using PBMC (Stankevich et al. 2005):

- Sweden
- Netherlands
- Norway
- France
- Estonia (63% of national roads)
- Serbia and Montenegro (8% of national roads)
- South Africa (100% of national roads)
- Zambia
- Chad (17% of all season roads)
- Philippines (231 km of national roads).

According to the World Bank, preparations were being made for PBMC in the following countries as of approximately 2005 (Stankevich et al. 2006):

- Albania
- Cape Verde
- Chad
- Madagascar
- Tanzania
- Burkina Faso
- India
- Cambodia
- Thailand
- Indonesia
- Vietnam
- Yemen, Republic of

REASONS FOR DOING PERFORMANCE-BASED MAINTENANCE CONTRACTING

An agency might decide to do PBMC or expand the amount of this type of contracting for numerous reasons. Many of these reasons are discussed in more detail in chapters three and four. Following are commonly cited motivations:

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

- Reduction in contract administration requirements (Hardy 2001; Pakkala 2002; Stankevich et al. 2005; panel member input; survey input).

Foreign countries have a number of additional compelling reasons to use PBMC. Developing countries cannot afford to let their highway systems deteriorate to the point at which they must be reconstructed. Reconstruction is very expensive compared with timely maintenance and diverts limited funds from transportation or other sectors where money is badly needed. Indeed, a maintenance organization using PBMC is likely to benefit from a higher LOS if substantial deferred maintenance has occurred (AASHTO 2002).

Also, securing funds for long-term contracts, such as in South America, makes it difficult to divert funds to other purposes or sectors (Hardy n.d.). Finally, international lending institutions, especially the World Bank, encourage countries to adopt PBMC (Stankevich et al. 2005).

IMPEDIMENTS TO PERFORMANCE-BASED MAINTENANCE CONTRACTING

Although there are many attractive reasons to undertake PBMC, there are numerous reasons for not doing so. Some of impediments cited in the literature and the survey responses include the following:

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

- Concern of union members that PBMC will undermine wages, benefits, work conditions, and job security that government provides
- The need to secure substantial funds through the budgetary process for large, multiyear contracts
- Concerns about the contractor's ability to effectively handle reactive maintenance, such as snow and ice control, repair of traffic control devices, and incident and emergency response
- The challenges of reassuming the responsibility for maintenance if the contractor fails to perform, especially if the contracting agency sells off its equipment and lays off all its maintenance staff except those who are necessary to administer the maintenance contracts (Pakkala 2002; Ribreau 2004; Hill et al. 2007; Science Applications International Corporation 2007; survey responses; and panel member input).

ADVANTAGES AND DISADVANTAGES OF PERFORMANCE-BASED MAINTENANCE CONTRACTING

Many close observers of PBMC have discussed the pros and cons of this type of contracting. One observer who has written extensively on PBMC lists these advantages and disadvantages:

- Advantages
 - Potential reduction in costs
 - Improved level of service (could cost more)
 - The transfer of risk to the contractor
 - More innovation
 - More integrated services
 - Enhanced asset management
 - Ability to reap the benefits of partnering
 - Building a new industry
 - Achieving economies of scale.
- Disadvantages
 - A more costly procurement process
 - A longer procurement process
 - A reduction in competition
 - Uncertainty associated with long-term contracting relationships
 - Challenges in mobilizing
 - Loss of agency control and flexibility; for example, to reallocate funds when there are large long-term commitments.

[Note: Some items have been tempered to be more general; for example, “potential reduction in costs,” instead of “reduction in costs” Pakkala (2002)].

BENEFIT-COST FRAMEWORK

It is natural to ask the question if in a particular instance or setting whether PBMC is worth the cost. An economist might ask, “Do the benefits exceed the costs?” A person experienced with PBMC in the international arena put the question this way: “Is there value for money?” (Hardy 2001).

$$\text{VALUE FOR MONEY} = \frac{\text{Change in Levels of Service}}{\text{Change in Costs}}$$

Although PBMC has many advantages and disadvantages, whether PBMC provides value for money to the contracting agency and its customers can be boiled down to one of the following three simple criteria:

- The LOS remain the same while cost declines
- The LOS improve for the same cost
- The LOS improve and cost declines (Hardy 2001)

Strictly speaking, a benefit-cost framework would identify discounted future streams of benefits and costs in dollars, which lends itself to life-cycle cost analysis and an examination of avoidable user costs such as travel time. However, there are so many outcomes of a maintenance program that some type of multi-attribute benefit function, such as weighted LOS, makes more sense as a measure of benefits. The multi-attribute benefit function can, in addition to levels of service, incorporate discounted streams of different types of benefits, including avoidable life-cycle cost, accident, travel time, and pollution costs.

Levels of Service

LOS pertain to all the dimensions of performance a contractor must address. For a single maintenance activity, such as line striping, there may be just a small number of performance criteria; for example, retroreflectivity, the percent of the line that remains intact, and the timeliness of response to repaint a line with poor reflectivity or a broken section. For contracts that involve numerous maintenance activities, performance criteria could consist of a large number of performance measures and corresponding targets. Frequently, the values for different measures of performance are rolled up into an overall rating. The LOS that comprise the overall rating reflect many things, such as the condition of assets (e.g., pavements, bridges, guardrails, and crash attenuators); the response of maintenance services (incident management, snow and ice control); and mobility, safety, environmental, and aesthetic issues

(Smith et al. 1997). Ratings are often grouped into useful categories such as pavement, traffic, roadside, and overall (Graff 2007).

Contracting agencies normally examine the LOS for individual or groups of assets or maintenance activities. Bar charts such as those in Figure 1 are typical. If over time the LOS for most activities or assets goes up, then the conclusion is the overall level of service has improved. Figure 1 shows that under performance-based contracts on both Interstate 35 and Interstate 20 in Texas, there was a period in which the overall maintenance rating declined for some time and then began rising.

Evidence on whether PBMC results in improved LOS is provided in the numerous case studies in the next chapter. Sometimes, in aberrations such as those shown in Figure 1, service levels decline for one or more years during the early part of the contract. In other instances, an agency successfully achieves its goal of reducing costs while maintaining the LOS in-house staff have achieved in the past. Another possibility is LOS quickly rise because the roads and maintenance appurtenances are in poor shape. This may require rehabilitation of many roadway sections before contract maintenance begins on those sections. Under such circumstances, there may be a significant investment and no cost reduction. Agencies frequently set performance standards at levels consistent with maintaining assets in good or excellent condition and with providing good or excellent service to road users; for example, mowing grass at intersections to maintain good sight distance.

Cost Savings

There is evidence from a number of sources concerning the cost savings of PBMC (Pakkala 2002; Segal et al. 2003; Stankevich et al. 2005; Zietlow 2005a). Table 4 shows estimated cost savings regarding PBMC in many countries around the world.

TABLE 4
COST SAVINGS OF PBMC RELATIVE TO CONVENTIONAL CONTRACTS IN SELECTED COUNTRIES

Country	Cost Savings
Norway	About 20%–40%
Sweden	About 30%
Finland	About 30%–35%
Holland	About 30%–40%
Estonia	20%–40%
England	10% minimum
Australia	10%–40%
New Zealand	About 20%–30%
United States	10%–15%
Ontario, Canada	About 10%
Alberta, Canada	About 20%
British Columbia, Canada	Some, but might be on the order of 10%

Source: P. Pakkala cited in World Bank Transport Note No. TN-27, Sep. 2005.

Published information indicates that the cost savings can be measured against engineers’ bid estimates, the cost of in-house staff to perform the maintenance before the contract, the cost of performing maintenance by a control group (usually in-house staff), or other baselines. Frequently, the literature does not clearly state the basis for the cost comparison.

No easily accessible documentation—reports, technical papers, and Internet material—is available to support the information in Table 4. In most cases, these numbers are almost certainly the product of expert judgment, because the cost savings for each country refer to multiple performance-based contracts. Also, it is not clear over what years the cost savings were achieved.

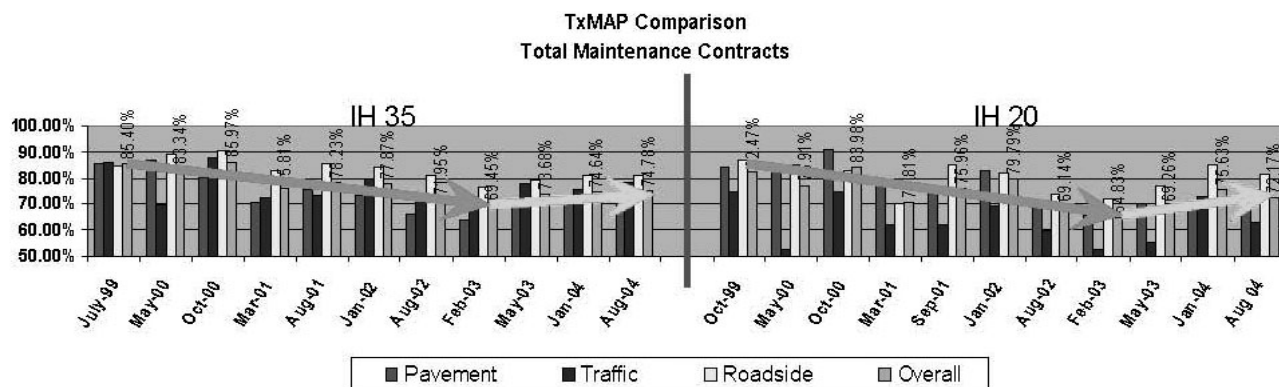


FIGURE 1 Example of rollup and time series for PBMC performance measures (Source: Graff 2007).

Nonetheless, it is known that a number of transportation agencies around the world have gone to substantial lengths to compare the costs of PBMC with other forms of maintenance delivery. For example, the Road and Traffic Authority (RTA) of New South Wales conducted a 12-month pilot in Sydney, Australia, that allowed a comparison of maintenance efficiency of (1) a 100 km section of road maintained by a contractor under management of a private sector project manager; (2) a similar 100 km section of road maintained by RTA public employees under management of a private contractor; and (3) the balance of the publicly owned network maintained and managed by RTA employees (Smith et al. 1994).

The Finland Road Administration (Finnra) created a wholly distinct production unit, the Finnish Road Enterprise (FRE), which competes with maintenance contractors throughout the country. The FRE, composed largely of former public employees, competed successfully for a large number of contracts. The reported cost savings of FRE is likely to be defensible because the FRE cost structure was well known to Finnra when it was a public agency. The key questions are (1) by how much did FRE's costs change once it was created? and (2) was it feasible to compare FRE's costs to Finnra's historical costs of performing the same or similar maintenance work?

Many maintenance managers regard the cost savings of performance-based contracting as unproven or difficult to substantiate. It is difficult to establish the difference in the cost of government agency forces and private contractors performing the same types of maintenance work (Ribreau n.d.). Another challenge is that some of these savings may reflect the difference in the government's initial cost estimates to contract out versus the award amount. Frequently, a more sound approach is to base the evaluation on actual costs before and after PBMC.

Another problem is establishing defensible direct and indirect costs for each type of maintenance activity in both the public and private sectors. The private firms will not publicize their cost structure, because it would undermine their ability to compete successfully. State DOTs are generally unable to accurately distinguish between direct and indirect costs. Two state DOTs tried to estimate their direct and indirect costs by attempting to adopt Activity-Based Costing, efforts that were never completed (S. Wilcox, personal communication, Nov. 2005; R. Arnebeck, personal communication, Sep. 2006).

It is also difficult to determine whether maintenance work over a contract increases or decreases life-cycle costs. If the contract term is relatively short, the contractor usually has no incentive to expend funds on projects with service lives longer than the contract term. Generally, lengthening the term of the contract helps align the owner-agency and the contractor's interests. If a performance-based contract includes road and bridge work with service lives in the 20- to 50-year range or more, it is difficult to perform before-and-

after studies. Preparation of estimates of cost savings based on deterioration and life-cycle cost models appears to be the only way an agency can estimate cost savings over the long run or beyond relatively short contract terms.

Finally, when the executive or legislative branch directs a transportation agency to downsize or caps its growth despite increasing maintenance needs, the capacity of the maintenance organization to perform all the needed work diminishes. The point is reached at which there may be no alternative but to outsource a significant part of the maintenance program. The agency is quite likely to respond to the outsourcing mandate without first collecting data to support rigorous and defensible before-and-after comparisons.

Through late 2004, the performance-based maintenance contracts in Australia, New Zealand, and the United States were reported to have achieved significant reductions in costs. However, for Latin American contracts, no equivalent information on cost savings is available. Some contracts were awarded for sums below the expected price, which points to possible cost savings. The DNER [Departamento Nacional de Estradas de Rodagem] in Brazil canceled a procurement for Performance Contracts because the contractors' bids were in excess of available funds. The bidders factored in the risk that the government might fail to honor its commitments. The upshot is that performance-based contracts might not yield cost savings right away (Zietlow 2005a).

There is to date insufficient substantive evidence to state categorically that the initial "savings" are a true reflection of increased value for money. It is, however, similarly impossible to state that this is not the case (Hardy 2001).

In 2007, a Swedish analyst published an online paper that attempted to apply regression analysis to determine whether cost savings resulted from PBMC in Sweden, southern Canadian provinces, and the state of Washington (Stenbeck 2007). This appears to be the first effort to rigorously apply statistical or econometric techniques to determine whether PBMC leads to cost savings. Indeed, the author states that quantification and comparison of contracting outcomes based on ex post data and new methods appears to be a research need in both Sweden and North America. Although the analysis suggested that cost savings were achieved contrary to the author's expectations, the estimated savings was not defensible for many reasons, including unclear explanations, choice of explanatory variables, and a small data set. Even so, the effort was laudable; however, more observations involving higher-quality and more credible data are required along with a reexamination of the methodology and the variables included in the regression equation.

In summary, frequently unsubstantiated, inconsistent, and incomplete information exists regarding cost savings that have been achieved for specific performance-based maintenance contracts. Appendix C provides information

regarding different efforts to estimate cost savings for many performance-based contracts. Despite different cost estimates, different methodologies, and information that is often less than persuasive, some patterns do emerge. Interpretation of these patterns and conclusions that might be drawn is left to the reader.

Value for Money

The equation (shown earlier) representing “value for money” accounts for changes in LOS relative to changes in cost. Many are persuaded that PBMC results in value for money. Others question whether estimates of cost savings are credible (“Review of Highway Outsourcing” 2004) and point to legislative audits that conclude that particular estimates of cost savings are not defensible. Still others may be skeptical of specific results concerning changes in LOS.

Value for money does not always reduce to two factors. Having a guaranteed price, being able to shift resources (labor and equipment) to other parts of the network where they are needed, and achieving administrative efficiencies not easily reflected in costs are just some of the other factors that can cause PBMC to yield net positive value.

ALLOCATION OF RISKS

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

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

Certain types of performance-based maintenance contracts place an upper limit on a transportation agency’s payments to the contractor. Lump-sum contracts with deductions for failing to meet performance targets are used around the world, although contracts that also have positive financial incentives may produce better outcomes. Furthermore, by lengthening the period of performance of a PBMC, the agency can reduce the risk that a contractor will ignore long-term goals, such as minimizing life-cycle costs, when it makes short-term decisions. With long-term contracts, the

contractor is also better able to amortize facility and equipment costs. Using a prequalification process further minimizes the risk to the contracting agency.

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

BASIC STEPS OF PERFORMANCE-BASED MAINTENANCE CONTRACTING

The literature and the surveys administered for this synthesis revealed that there are many different ways to list the steps of a PBMC. One state provided a list of steps for a rest area performance-based contract. This list of steps, with a few modifications, is fairly generic and is applicable to many PBMC business processes that states, provinces, cities, and counties have adopted or might adopt:

1. Discuss types of maintenance, geographic areas, and portions of the roadway network that would benefit from PBMC;
2. Decide on the types of maintenance and area/roads that will be the focus of the contract;
3. Complete an inventory of assets;
4. Assess inventory condition;
5. Bring items up to par or make this a contractor requirement;
6. Determine the scope of services;
7. Define the LOS (condition) to be achieved;
8. Define qualifications of prime and subcontractors;
9. Set term of contract;
10. Address recordkeeping;
11. Define owner responsibilities;
12. Define contractor insurance requirements;
13. Determine bonding requirements;
14. Establish payment criteria including incentives and disincentives;

15. Develop an approach for performing inspections;
16. Draft Request for Proposals (RFPs);
17. Establish monthly payment with adjustments for performance incentives and disincentives;
18. Hold prebid meeting;
19. Finalize and issue RFP;
20. Make award;
21. Conduct meeting with contractor before start of work;
22. Authorize work to begin;
23. Allow contractor to perform work;
24. Conduct periodic and random inspections of performance;
25. Make monthly payments to the contractor in accordance with performance; and
26. End contract, unless it is renewed for a subsequent term.

There are many possible variations in the steps of a performance-based maintenance contract. Although some agencies try to establish asset inventory and condition before issuing an RFP, others leave this responsibility to bidders and believe that no contractor will bid unless it has a reasonable concept of what the future maintenance requirements will be. Most contractors will not take the risk of depending entirely on the agency's estimates of the number and condition of each type of asset that must be maintained.

Some other variations in the business process for PBMC include microcontracting to develop a pool of subcontractors (Zietlow 2005b), self-monitoring and reporting by contractors, performance evaluations by independent third parties, and combinations of performance evaluations involving the contractor, the owner–agency, and an independent third party.

A radically simplified form of PBMC, discussed in the next chapter, is the “Statement of Objectives” procedure, which many federal agencies have used. Also, PBMC might be integrated into a design-build-finance-operate contract or a toll road concession.

ACQUISITION PROCESS

Obtaining qualified contractors to perform under a performance-based maintenance contract requires the contracting

agency to have an appropriate selection process. The contracting agency must perform due diligence to ensure that the winning contractor is able to achieve the desired performance standards.

An agency cannot start too early in identifying potential contractors. The ways to do so include (1) identifying contractors that have performed similar work for other government agencies, (2) issuing a Request for Qualifications (RFQ), (3) inviting contractors to an information meeting or a prebid conference designed to encourage contractors to form teams, and (4) examining the feasibility of restructuring the government maintenance organization into a part that will administer the contract and another part that will compete for the work (Pakkala 2002; Hyman 2003). In a number of countries, governments will contract with a consultant or the equivalent of a system manager who in turn will oversee the activities of the contractor that will enter the performance-based maintenance contract (Pakkala 2002). The consultant or system manager can help identify potential contractors.

A key issue is whether there are enough contractors to bid on a contract to ensure that prices are reasonable. In Alberta, Canada, the Ministry of Transportation divided the province into Maintenance Contract Areas (MCAs) and periodically evaluated whether there was adequate competition. The transportation agency adjusts the maximum number of MCAs for which a firm can win a contract to try to ensure effective competition (Lali 2007). Other issues concerning competition are the availability of smaller subcontractors that can perform the work and whether there will be public-private competition.

The acquisition process includes preparing and issuing an RFP. The RFP will include the project objective, the scope of work, the dollar value of the contract and payment schedule, incentives or disincentives and payment adjustments, performance measures and targets, a description of the contract monitoring process, contractor requirements such as bonding and a quality control (QC) plan, an explanation of who will be responsible for performance reporting and monitoring, contractor selection criteria, and a sample contract.

TYPES OF PERFORMANCE-BASED CONTRACTS

There are a handful of different types of performance-based contracts (for some of these, see AASHTO 2002). They each differ according to scope and coverage. The scope refers to the activities and assets addressed and the coverage pertains to the amount of the highway network covered and the geographic area.

Single activity. A simple performance-based contract may deal with only a single activity such as sign replacement or striping.

Single asset. A performance-based contract may pertain to just one type of asset, but it could involve a single maintenance activity or multiple activities. A performance-based contract for bridge maintenance is likely to involve numerous bridge maintenance activities such as joint repair bearing replacement, and washing and cleaning.

Set of related activities. Sometimes a performance-based contract pertains to a set of activities that are related by virtue of their location, the type of asset they concern, or other factors. A good example is a contract that concerns rest area maintenance.

Corridor. Many performance-based contracts pertain to corridors, often long sections of limited access highways. These contracts are likely to address all activities necessary to maintain the assets in the corridor and ensure safe and efficient highway operations. These contracts frequently concern everything in the right-of-way and are sometimes called fence-to-fence maintenance contracts.

Areawide. A performance-based contract can concern areas of different size. A garage or area shop might have a performance contract that pertains to its area. An areawide PBMC could also concern a district, city, township, county, state, or country. An areawide contract could cover one activity or all types of maintenance activities and assets within the relevant boundary.

Hybrid. There are a variety of different hybrid contracts. One has a combination of method specifications and performance specifications. Another has incentives and disincentives that are both output- and outcome-driven. A third uses a combination of unit prices and a lump-sum payment, where the latter is adjusted based on whether or not the contractor meets performance standards.

Agency-to-agency. A public agency responsible for maintaining a roadway network contracts with one or more other public agencies to perform the maintenance. States may contract with counties to perform maintenance, as in Wisconsin. Many Michigan counties contract with the state for maintenance. States may also contract with cities or authorities for maintenance services under certain circumstances.

Warranty-based. These are contracts that require the contractor to warranty the workmanship and materials for one or more maintenance activities. Warranties require the contractor to maintain the end product in the condition specified for a certain number of years. Warranties can apply to pavements, rest areas, signs, striping, and so on. If the contractor fails to meet the terms of the warranty, then the contractor must fix the problem.

Multiphase. Some contracts involve more than one phase of an asset's life-cycle and may also include financing.

Examples include design-build-operate-maintain (DBOM), design-build-finance-operate-maintain, and finance-build-sale-leaseback-operate and maintain. Around the world, award of a concession is a common way to finance a toll road. The concession agreement requires the concessionaire to operate and maintain the toll road once it is built. All of these examples include maintenance under contract. These contracts may include performance-based specifications for maintenance.

The broader performance contracts include preventive maintenance, routine maintenance, periodic maintenance, and demand-responsive maintenance. Rehabilitation of roads and bridges has been part of many performance-based contracts.

In areas in which PBMC is a new practice, the road agency often finds the best approach is to first gain experience by contracting for maintenance regarding a single activity, a single asset, or one set of related activities in a single maintenance area. Once the agency has acquired experience, it is likely to expand the number of assets under contract, coverage area, and the period of performance. In short, it is usually best to start simply on a small scale.

Figure 2 shows the number of different types of performance-based maintenance contracts reported by the survey respondents that said they do PBMC (except the District of Columbia). The District's performance-based contract concerns a large number of types of maintenance activities on 75 miles of the NHS within its jurisdiction.

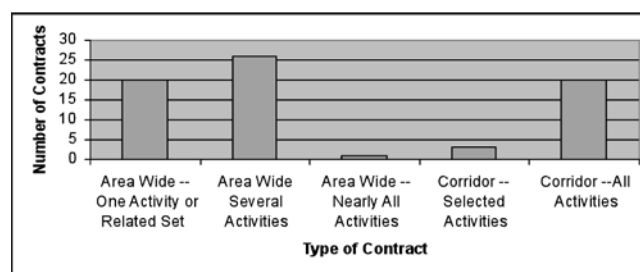


FIGURE 2 Number of different types of performance-based maintenance contracts from survey respondents reporting they do PBMC.

LINKAGE BETWEEN OBJECTIVES, MEASURES, MEASUREMENT, AND PERFORMANCE

Effective PBMC benefits from a clear understanding of project objectives. Ideally, the objectives stem from the objectives of plans and programs a performance-based maintenance project is intended to serve. Furthermore, measures should correspond to important activities for accomplishing the objectives. There could be generally accepted performance measures and compensation tied to achieving desired levels of performance (Hyman 2003).

Objectives and corresponding performance measures are often reflected in the various plans or programs of transportation agencies. A number of organizations have developed performance-based plans that include maintenance measures (Cambridge Systematics, Inc. 2000).

Performance-based planning has become common today in a large number of DOTs. In general, performance-based planning focuses on the projected outcomes of potential investments and the extent these investments support department policies. Performance-based planning uses systematic procedures and good analysis, and it relies on objective asset data and management systems. Goals and objectives, corresponding performance measures, trade-off analysis, and target setting are among the main characteristics of performance-based planning. The way of defining, combining, and aggregating performance measures is critical to success (Neumann and Markow 2004). The use of performance measurement and targets helps top management steer an agency in the desired direction and deal with the trade-offs in addressing competing and complementary goals and objectives. For purposes of performance-based planning, DOTs can draw on many recent compilations of performance measures, including those relevant to maintenance management (Booz Allen Hamilton 2002; Cambridge Systematics, Inc. 2000, 2006; Hyman 2004).

BASIC CATEGORIES OF MEASURES

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

1. **Inputs.** These are resources applied to maintenance. They usually consist of labor, equipment, materials, and the associated financial expenditures. In some instances, resources can include other things; for example, facilities or land.
2. **Outputs.** These are accomplishments or, in other words, how much work gets done. Traditional maintenance management systems record accomplishments (outputs) and resources used (inputs) upon completion of work. Some performance-based contracts specify the outputs to be achieved. Examples of outputs include lane-miles of bituminous resurfacing or linear feet of guardrail replaced. The amount of work done is a reflection of the efficiency and effectiveness of the organization performing the maintenance.
3. **Outcomes.** These are the results or changes that occur as a result of maintenance. To an increasing degree, PBMC is concerned with outcomes that are important to customers of roads. Depending on the type of maintenance being performed, customers can be viewed as road users, those who pay for the roads, and owners of property adjacent to roads that experience spillover effects such as the spread of invasive plants from the right-of-way. Examples of customer-oriented outcomes are as follows:
 - Smoothness of pavements
 - Visibility of signs and markings at night
 - Cleanliness of rest areas
 - Amount of litter along the road
 - Traffic signals quickly restored to operating condition after they stopped working properly (i.e., response times are frequently a part of performance-based maintenance contracts).
4. **Explanatory Variables.** It is desirable for the contracting agency and contractor to keep track of variables that can help explain resource utilization, outputs, and outcomes. Many explanatory variables are outside the control of the contractor and agency and include traffic growth, weather, emergencies, and terrain. Accounting for explanatory variables outside the contractor's control provides a basis for adjusting incentives and disincentives and more fairly allocating risk.

Performance-based contracts may include more than one type of measure. For example, there may be a combination of outcome and output measures along with method specifications (possibly including equipment requirements). However, the trend is toward reduction or elimination of method specifications and an increasing orientation toward customer-oriented outcomes as opposed to outputs.

In sum, while PBMC may involve many things, it is evolving toward a contracting procedure that provides both disincentives and incentives for achieving measurable targets or standards based on outcome-oriented performance specifications.

A FEW GOOD MEASURES VERSUS MANY MEASURES

Many experts on performance measurement advocate using just a few good or vital measures, sometimes also referred to as Key Performance Indicators. However, performance-based contracts can become excessively complex because of the large number of maintenance activities they address. A tension exists between having just a few good measures because of their simplicity and manageability versus having many measures in order to be complete and thorough. Transportation agencies throughout the world take different approaches, partly depending on the nature of the contract. Contracts focused on a single maintenance activity may use only a few measures, whereas contracts involving virtually all types of maintenance and operations pertinent to a major highway are likely to have many measures.

COMMONLY RECOGNIZED MEASURES

The AASHTO Subcommittee on Maintenance sponsored a national workshop on commonly recognized measures for maintenance (Booz Allen Hamilton 2002). It was noted that commonly recognized measures might be useful for a number of purposes including PBMC, benchmarking, and encouraging economies of scale in the manufacture of measurement instruments.

Great success has been achieved in the bridge area. Commonly Recognized (CoRe) elements and corresponding condition states have been defined, adopted by AASHTO, and used in biennial bridge inspections throughout most of the United States (*AASHTO Guide for Commonly Recognized (CoRe) Structural Elements* 1997). However, even after the AASHTO Subcommittee on Maintenance adopted a resolution to establish and adopt three new commonly recognized measures for maintenance per year; as of May 2007, little progress had been made in developing consensus on a specific set of measures. Areas in which maintenance performance measures are needed for PBMC include the following:

- Roadside (fences, guardrails, crash barriers)
- Shoulder (surface, striping, edge drop-off)
- Pavement—bituminous and concrete (roughness, rutting, skid, appearance)
- Signs, markers, striping
- Brush trimming, brush removal, tree cutting
- Control of invasive plants
- Planting and care of wildflowers and native vegetation
- Noise walls
- Drainage (catch basins, culverts, detention ponds)
- Bridges
- Snow and ice control
- Signals and other electronic equipment [e.g., intelligent transportation system (ITS) devices]

- Incident management
- Emergency response
- Removal of obstructions (dead animals, abandoned vehicles, objects on roads fallen off vehicles)
- Litter pickup
- Graffiti removal.

MAINTENANCE QUALITY ASSURANCE

NCHRP Project 14-15 resulted in a report entitled *Web Document 8: Highway Maintenance Quality Assurance (MQA)* (Smith et al. 1997). This report and a subsequent implementation manual set out a procedure for monitoring the LOS that have been achieved through maintenance activities performed by agency or contractor personnel. LOS measurements are taken on a sample of the roadway network and apply to the condition of various assets or outcomes being achieved through various maintenance activities and services. Sample size varies depending on the desired accuracy, the statistical confidence being sought, and the degree of stratification or number of organizational units from which information is being collected. All these factors affect the level of effort to collect LOS data, which sometimes is significant. MQA has been adopted by a large number of states and is frequently used in PBMC (Smith et al. 1997; Stivers et al. 1999).

Although the implementation of performance measures for monitoring outcomes under a MQA framework often has much in common from state to state, close examination of the measures reveals they are not the same.

In short, using MQA has become a common practice in PBMC, but specific measures vary from state to state (Smith et al. 1997). Nevertheless, because of the similarity of the measures, transportation agencies do piggyback on the work of others when developing their own performance measures.

EXAMPLE MEASURES, MEASUREMENT PROCEDURES, AND STANDARDS USED IN PERFORMANCE-BASED CONTRACTING

The crux of a performance-based contract is the performance measures and standards or targets to be achieved. An example of some performance measures and standards from a trans-Canadian highway project involving design, construction, finance, operations, maintenance, and rehabilitation appears in Table 5. Based on survey responses, it was determined that the agreement between the contractor and the transportation agency has approximately 50 different standards with 5 to 10 performance measures for each standard on average.

TABLE 5
EXAMPLES OF SOME PERFORMANCE MEASURES AND STANDARDS FROM A TRANS-CANADA HIGHWAY PROJECT

Measure	Measurement Procedure	Target (and unit of measure)
a. Roughness	IRI through high-speed data collections using ASTME950 Class I profiler	IRI of 2.28
b. Rutting	mm through high-speed data collections using ASTME950 Class I profiler	Rut depth 20 mm
c. Surface Distress	SDI Index through high-speed data collections using ASTME950 Class I profiler	SDI of 7.9
d. Potholes	Potholes greater than 150 mm in width and 75 mm in depth	Repaired within 48 hours
e. Grass Control	Mowing of foreslopes	Twice per year
f. Fence Maintenance	Annual inspections	By May 31 each year
g. Snow Plowing	Maximum allowable accumulation allowed on the facility	40 mm

Source: A private contractor survey response.

ESTABLISHMENT OF PERFORMANCE LEVELS

Performance levels expected of contractors can be established in a number of ways. One is to base them on performance levels achieved by in-house staff. A second option is to ask other agencies to identify their expected performance targets or compare performance targets used in MQA procedures adopted by different states, provinces, and countries. As stated earlier, the measures that states use differ from one to another, but sometimes only slightly. It is common to rate performance on a scale of 0–100 for all assets and maintenance services and set performance targets or standards at 80 (Smith et al. 1997). A related approach is to examine the literature, procurement materials (RFPs and RFQs), and contracts containing information on performance targets of different agencies. Third, one can conduct benchmarking studies, assuming the same performance measures are used. The NCHRP *Guide for Customer-Driven Benchmarking of Maintenance Activities* can provide a framework for establishing, measuring, and evaluating performance levels (Hyman 2006). A fourth possibility is to set stretch goals. Regardless of the approach taken, it is important to address the establishment of performance measures and targets early in the contractor acquisition and partnering process. This helps to ensure that desired targets are realistic and agreeable to the agency and potential bidders. Another important consideration is technological change, which can significantly alter expectations regarding the level of performance that can be achieved. Finally, it is important to account for life-cycle cost and other long-term considerations in relationship to the term of the contract and scope of work allowed (e.g., maintenance and rehabilitation). To set high pavement and bridge performance targets for roads and bridges in poor condition under a short-term maintenance contract is not reasonable.

Criteria for Establishing Performance Standards from the Performance-Based Maintenance Contracting Course presented in San Antonio, Tex., Mar. 2007

- Can the contractor influence the performance standards?
- Is the performance standard specific?
- Is the performance standard measurable?
- Is the performance standard achievable?
- Is the performance standard results-oriented?
- Is the performance standard timely?
- Has the standard been measured here before?
- Does the standard conflict with the agency's standard specifications?
- Is the standard in line with the agency's objectives and desires?
- Is it practical to apply and readily observe?
- Does the performance standard focus on what really matters (i.e., focus on the assets/actions that make a difference in preserving the asset)?
- Is the standard close to what is being currently achieved or is the aim to improve performance?
- Is the standard balanced between what is required to achieve it and the dollars available to achieve it?

Source: Science Application International Corporation 2007.

INCENTIVES AND DISINCENTIVES

A broad range of incentives and disincentives are used for performance-based contracts. Many approaches come from highway sector experience with PBMC in the United States and abroad. However, a great deal of experience with PBMC has been accumulated by a large number of agencies in the federal government. Furthermore, state government outside transportation routinely innovates in this area.

Issues in Providing Incentives and Disincentives to Contractors

PBMC involves many considerations in deciding how to encourage a contractor to achieve the desired results. Some agencies use only disincentives; for example, a lump-sum payment with deductions for failing to meet performance targets. Others use a combination of incentives and disincentives. Another possibility is A+B+C contracting for a multiphase project such as DBOM. A is the total price for bid items; B is the amount of time to complete the work, which is multiplied by the road user cost; and C might be the warranty cost for performance-based maintenance (Anderson and Russell 2001). Because of the partnering feature of PBMC, a contractor is often able to provide feedback on the incentive structure during the acquisition process and before an RFP is issued.

Alternative Approaches

In practice, incentives and disincentives are usually tied to achievement of targets for outcomes and timeliness of performance (e.g., see Transit New Zealand 1998). Sometimes the contractor is provided with financial motivation to achieve certain output levels. Other possibilities, as mentioned earlier, include contract renewal as an incentive (option years), award fees for more subjective aspects of performance, and incentives for completing certain work early. Disincentives frequently include deductions for failing to meet performance targets and liquidated damages for failing to comply with specific contract terms.

Types of performance-based contracts, often used in federal performance-based service contracts include the following:

- Fixed-price (lump-sum) plus disincentives (deductions/liquidated damages) and possibly incentives
- Cost plus with incentive fees or disincentives/liquidated damages
- Fixed-price or cost plus with an award fee
- Fixed-price or cost plus with an award term (*Air Force Guide ... 2003; Federal Acquisition Regulation 2005*).

Based on the literature review, the most common performance-based contracts in the highway sector involve lump-sum payments and deductions for failing to meet performance standards, with at least one option to extend the contract term.

ROLES AND RISKS OF KEY PLAYERS

PBMC typically shifts a large portion of the risk of a maintenance contract from the owner–agency to the contractor.

The contractor is responsible for performance and is free to choose the methods it wishes to apply to achieve performance, although in practice states and other jurisdictions frequently require the contractor to fully comply with its traditional maintenance specifications. A true performance-based contract promotes innovation and efficiency, which are major benefits of this approach. A number of other factors also affect project risk, including weather, environmental issues, traffic mix and growth, duration of the contract, the availability of resources to the contractor to carry out the work, the nature of penalties, and whether the contractor must warranty its work.

Contractors have different views regarding the desirability and acceptability of forcing most or all of the risk on them. At least one contractor sees the ability to accept a large portion of the risk as a market opportunity. Another contractor appears unwilling to accept so much risk. This contractor suggested that, in the absence of adequate risk-sharing, it would prefer not to bid. Most experts recommend some degree of risk-sharing (Pakkala 2002) if not sharing both risks and rewards (Science Applications International Corporation 2007).

CONTRACTOR SELECTION CRITERIA

The criteria agencies have used to select contractors vary from organization to organization. Selection criteria may be required by law. To apply a selection process not authorized by law would require legislative change. Prequalification and postqualification (i.e., before or after receiving bids) occur in different agencies around the world.

Selection Criteria

Contractor selection criteria include low bid, modified low bid, best value, Qualifications-Based Selection (QBS), and technical submittal and negotiation. Low bid may be elective or a legal requirement.

Modified low bid introduces nonprice considerations by weeding out potential bidders that cannot satisfy minimum qualifications. Modified low bid can be accomplished by using a pre- or postbid qualification process. The contracting agency picks the contractor offering the lowest bid from the set of pre- or postqualified bidders (Science Applications International Corporation 2007).

Selecting a contractor based on best value involves giving a certain percentage weight to technical considerations and the remainder to costs. Table 6 shows representative weights used in different countries from around the world. Many different criteria may be used to determine the technical score, such as the following:

TABLE 6
REPRESENTATIVE WEIGHTS USED IN DIFFERENT
COUNTRIES

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

Source: Pakkala (2002) cited in Stankevich (2005).
WA = Western Australia.

- Understanding of project and PBMC approach
- Relevant management and technical experience
- Staff qualifications
- Capacity to perform the work
- Proposed work plan
- Past performance on similar work and record of completion of past projects
- Quality plan
- Customer and community involvement
- Ability to handle risks including incidents, severe weather, and emergencies (Pakkala 2002; Stankevich et al. 2005).

Specific contracts may include or omit various criteria. For example, the selection criteria for the evaluation of bids to maintain the 75-mile NHS in the District of Columbia in the United States included technical and cost considerations. Noncost factors included technical, staffing, QC/quality assurance (QA), management, and past performance. These factors accounted for 50% of the total score; cost was 50% (Stankevich et al. 2005).

If design is part of the project, as in a DBOM project, state law frequently requires a QBS process. QBS involves issuing an announcement for needed services, identifying a short list of qualified respondents, entering into discussions with each firm, ranking the firms based on their qualifications, negotiating with the highest ranked firm, entering into a contract if the negotiations are successful, turning to the bidder with the next highest ranking if the negotiations are unsuccessful, conducting negotiations, and so on (Michigan QBS Coalition n.d.)

If the procurement process simply involves a technical submittal followed by negotiations, the contracting agency will determine the bidder with the best technical qualifica-

tions, and then enter into negotiations with that party until they agree on a price (*A Guide for Methods and Procedures in Contract Maintenance* 2002)

INTERNAL AGENCY SUPPORT AND UNIONS

Although PBMC is being adopted by increasing numbers of transportation agencies throughout the United States and other countries, the willingness of agency staff to embrace it is essential to implementation. Many agencies are skeptical that contractors can satisfy critical needs such as snow and ice control, incident management, and emergency response (Ribreau 2004).

Virginia Department of Transportation's (VDOT's) experience is just the opposite, however. The legislature mandated that all interstate maintenance work in Virginia be performed under contract. Based on prior interstate maintenance experience, VDOT became comfortable with the contractor's ability to address snow and ice control, incidents, and emergencies. However, VDOT is less optimistic about the ability of PBMC to address long-term pavement and bridge needs, whose design lives could easily range from 25 to 75 years, respectively, well in excess of the maximum term of a performance-based maintenance contract (Robert Prezioso, personal communication, Mar. 2007).

Resistance to PBMC can arise because of the long history of agency staff providing maintenance services; many maintenance managers cannot envision another way. Another factor is the posture of unions. Many unions across the country may see performance-based contracting as a threat to their jobs, wages, and benefits. Other unions acknowledge that the continued pressure by politicians to downsize agencies leaves those unions little choice but to go along with PBMC and work with both transportation departments and contractors in a constructive manner.

Regardless of which direction a union turns, the union is likely to initially challenge or criticize the decision to contract out work. Unions may desire to include contractual provisions that pertain to granting employees advanced notice, bidding procedures for public employees, minimum cost savings to be achieved, and the rights of displaced employees.

Because contracting can be undertaken for a variety of reasons—such as to reduce costs, improve the quality of maintenance services and assets, and address legislated mandates or arbitrary caps on public employment levels—unions do not always see PBMC and other types of contracting as directly related to quality or efficiency.

Unions often question why the private sector is credited with being able to achieve cost savings when public employ-

ees believe they work under constraints that prevent them from achieving similar reductions in costs.

Performance measures are often used to explain why contracting out provides more value. How the union and management resolve issues concerning the development and use of performance measures helps determine the union's acceptance or resistance. Thus, the union's role as a stakeholder in the performance outcomes of the agency will influence its opinion of performance measures. Other factors that influence the union's receptiveness to contracting and performance measures include the following:

- Has the employer fully shared the rationale that motivates the performance contract?
- Has the union been given adequate notice and an opportunity to make a proposal to do the work or remedy the problem that the proposed contract is aiming to resolve?
- Does the employer partner with the employees in this effort or do the employees develop their own proposals?
- To what extent are performance measures used regarding maintenance work and to what degree have employees been involved with defining performance goals, measures, and targets? Is the union aligned with the general performance goals of the employer?
- Does the union see the employer as doing all it can to improve the capacity of the agency so that it believes contracting out is a reasonable alternative?
- Are there different performance measures for a contractor than what is expected of the current workforce? If measures are different, has a reasonable opportunity been offered to the current workforce to meet the contract standards?
- Does the current labor–management relationship as evidenced by joint labor–management initiatives give any focus to agency performance outcomes?

A “no” to any of these questions can lead to resistance. Past constructive involvement with the union as a stakeholder is a predictor of its response to contracting and performance measures.

It is common for the union to ask for a chance to be able to perform the maintenance work to the same performance standards that would be required of a contractor or to make proposals to return outsourced work to the agency. The union may seek a “level playing field” so that a comparison with the contractor properly weighs costs, quality, and avoidable barriers that increase public costs. The union may seek to monitor the contract to see whether the contractor meets deliverables. Overall, the union is going to be sensitive to its members and their sentiments—the organization's human assets—and it will seek investments in staff, equipment, or work design to help them become competitive (Wyngaard 2007).

In Finland, the Finnish Road Administration undertook a radical reorganization and created a large portion of the agency as a separate, but wholly owned, delivery organization called the Finnish Road Enterprise to compete with private contractors. Finnra retained responsibility for program management and procurement.

The Finnish Road Enterprise won 78% of the performance maintenance contracts (some were hybrids). As a result, Finnra found it necessary to create incentives for the private sector to continue to bid on the performance-based maintenance contracts. Finnra issues stipends to those bidders that did not win and paid for a portion of the costs of preparing a bid (Stankevich et al. 2006).

PARTNERING AND FRAMEWORK FOR PERFORMANCE-BASED MAINTENANCE CONTRACTING

For PBMC to succeed, it must first and foremost be viewed as a partnership between the contracting agency and the contractor. Some reasons to form a partnership are to build trust, establish a direct way to resolve issues, develop common goals and objectives, foster creativity and innovation, better manage risk, work together to reduce costs, and jointly strive for improved LOS and customer satisfaction. Good practices in partnering have an important role to play in PBMC. There is extensive literature on partnering and its benefits regarding construction and other transportation activities (*Quality Accomplishments Report ... 1997*; Pakkala 2002; Stankevich et al. 2005). Those benefits are evident in PBMC according to survey responses.

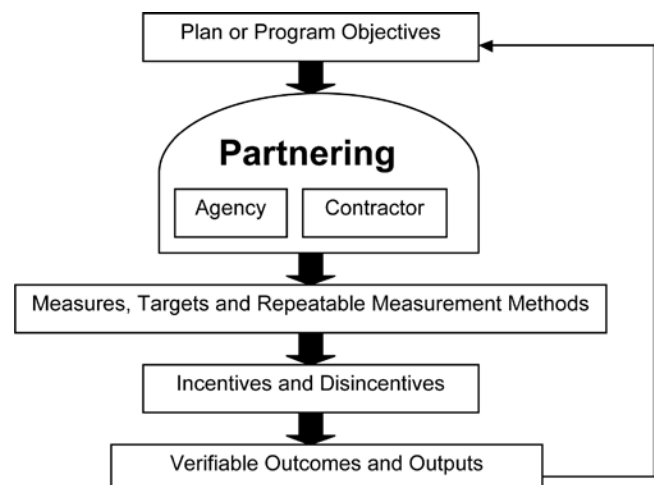


FIGURE 3 Analytic framework for performing research.

Figure 3, presents a framework that has four key features:

1. Partnering between the contracting agency and the contractor. Partnering also needs to extend from the contractor to subcontractors.

2. Measures and repeatable measurement procedures that relate to the project and stem from plan and/or program objectives.
3. Outcomes and outputs that can be verified through measurement and evaluation.
4. Incentives and disincentives that encourage the contractor to achieve performance targets.

MONITORING AND EVALUATION OF CONTRACTOR

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

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

The third approach is to use an independent third party to conduct contractor evaluations; a method that provides the most objectivity. It also leaves room for the agency and the contractor to develop a strong partnering relationship, because the burden of evaluation lies with neither the agency nor the contractor. There will be an added cost of an independent evaluator, but it is likely to lead to monetary and nonmonetary benefits (Science Applications International Corporation 2007).

TRAINING

Introduction of PBMC can go relatively smoothly or be a disruptive experience for several reasons, in part, because staff and contractors must be prepared to make a significant cultural change. Agency staff must resist thinking in terms of compliance with method specifications and remember the contractor is focused on achieving specific results. Both agency and contractor staff must cease to think in terms of bid quantities and come to terms with a new payment scheme that provides negative and possibly positive incentives for achieving performance standards. Agency staff and contractors may be unaccustomed to the partnering that successful PBMC demands (Science Applications International Corporation 2007).

Training has a major role to play in bringing about this shift and to help ensure that PBMC works. Furthermore, as an agency accumulates experience with PBMC and undertakes new contracting efforts, there is a need to communicate lessons learned. Some examples of topics on which training reaps large benefits are as follows:

- The acquisition process
- Understanding and use of performance measures and standards
- Contractors communicating to subcontractors their roles and responsibilities
- Agency and contractor implementation of effective practices and lessons learned
- How to get the most from partnering
- QC and QA procedures
- Evaluation of contractor performance.

CONTRACT TERM AND RENEWALS

Selecting a desirable contract term and renewal terms is a key issue (*A Guide for Methods and Procedures in Contract Maintenance* 2002). Some agencies want a short initial term in case the contractor fails to perform or to be in line with budget realities (Stankevich et al. 2005; Hill et al. 2007). Other agencies would like the initial period to be long enough so that contractors can fully depreciate their equipment and therefore offer a lower price. Many agencies lean toward a long first term because the contractor will make decisions more in tune with the long-term interests of the agency; for example, minimizing life-cycle costs. Recently, the British Columbia Ministry of Transportation increased its contract term from seven to 10 years (Stankevich et al. 2005). As implied earlier, VDOT recently decided not to include bridge and pavement work in its legislative-mandated interstate

maintenance contracts because pavement and bridge lives substantially exceed the term of typical performance-based maintenance contracts (Robert Prezioso, personal communication, Feb. 2007).

Determining a good pattern of renewals involves many issues. One is to provide an incentive to the contractor to meet or exceed the performance targets in the first term. Contract renewal brings with it the benefits of continuity. Another reason is to provide for the possible replacement of the contractor under the threat of competition. Periodically reissuing RFPs also provides an opportunity to assess the competitive environment and the capacity of contractors to ensure downward pressure on bid prices. The province of Alberta has found this periodic tendering process and stock-taking valuable (Bucyk and Lali 2005).

MAINTENANCE, RESOURCE, AND FINANCIAL MANAGEMENT SYSTEMS

The business process for PBMC ideally requires both the contracting agency and the contractor to have suitable management systems. Capabilities of the contractor's system could include QC, the ability to keep track of the asset inventory and its condition, a means to predict future condition or remaining life, a way to develop maintenance plans, software to track resource availability and usage, a work order and scheduling system, and a means to conduct important financial and economic analysis. The public agency may wish to have many similar capabilities (Markow et al. 1994; Smith et al. 2003).

ADDITIONAL OBSERVATIONS

This chapter has highlighted some important considerations in PBMC and serves as a prelude to the rest of this synthesis report. Some observations pulled from the remaining chapters may be useful to practitioners (see Table 7).

LESSONS LEARNED

The body of knowledge on PBMC has resulted in many lessons learned, including the following:

- PBMC involves politically and socially sensitive decisions.
- A significant cultural shift of both the owner–agency and the contractor is usually required for PBMC to be successful.
- Adequate contractor capacity is necessary to ensure meaningful competition and to be confident that a contractor and its subcontractors can achieve the performance standards.
- The more an agency does PBMC, the more its role shifts from managing and performing maintenance work to planning, contract administration, and contractor oversight. The skills an agency requires must shift accordingly.
- The RFP and contract both require a clear scope of work.
- Agencies beginning with PBMC could start with projects that have a limited scope, such as one maintenance activity (rest area maintenance) or relatively few activities (e.g., routine maintenance) on a section of road.
- Performance measures must be clearly defined, the measurement process repeatable, and targets realistic and in line with the agency goals. In short, performance specifications must be clearly defined.
- The contract must have the proper incentives and disincentives.
- A firm funding commitment is required for multiyear performance-based contracts.
- Cost savings are highly desirable but difficult to document. Cost savings are often claimed based on the difference between the agency's estimated cost and the amount of the contract award.
- Quality (LOS) sometimes suffers during the first year on long-term total asset management contracts. Quality is likely to improve the first year on performance-based contracts where serious maintenance has been deferred or LOS have been low.
- If the highway or network is severely deteriorated, it needs to be reconstructed or rehabilitated before standard performance-based maintenance procedures begin. In numerous cases around the world, the contractor has been responsible first for a rehabilitation phase and then a maintenance phase.
- Partnering and trust are imperative between the maintenance organization and the contractor.
- A poorly written contract, or either party misreading significant portions of the contract to serve its own interests or point of view, may lead to failure.
- Failure is likely to occur if agency staff believes strongly that contractors are taking their jobs. If agency staff are responsible for monitoring contractor performance, they may be overzealous in holding contractors to timeliness requirements and other performance standards.
- Expect failure to occur occasionally because success cannot occur 100% of the time. At times, certain events and conditions will prevent performance-based contracting or performance-based warranty contracting from working. An agency with poor contractor performance or a disappointing outcome might try to learn from its experience and carefully try again.
- Warranties and performance bonds can help mitigate failures. Bids will be higher if contractors have to ensure against failure.

TABLE 7
ADDITIONAL OBSERVATIONS REGARDING PBMC

Topic	Observation
Use of PBMC	PBMC is rapidly becoming more prevalent in the U.S. and abroad, but currently it is a practice of a small minority of maintenance organizations.
Type of performance-based contract	Areawide and fence-to-fence contracts along a highway corridor are the most common. PBMC for rest areas is becoming more common.
Reason for not doing PBMC	The most frequently cited reason is agencies have not done PBMC and have the internal resources to perform the maintenance.
Reasons for doing PBMC	Two important drivers for performing PBMC are the following: transportation agencies do not have enough labor to do all the maintenance required (frequently owing to downsizing, caps on the number of employees, and growing maintenance demands) and PBMC is a logical extension of past contracting practices.
Top-down formulation of performance measures	Fewer than half of transportation agencies set out maintenance performance measures in their plans or programs.
Identifying and engaging qualified contractors	The vast majority of agencies that have pursued PBMC try to identify qualified bidders early in the process, conduct pre-bid meetings to allow for questions and answers, and permit contractors to perform their own inventory and condition assessment.
Maintenance quality assurance (MQA)	More agencies use a MQA process to monitor contractor performance than to monitor the performance of in-house staff.
Hybrid contracts	More than half of those agencies with performance-based contracts include both method and performance specifications.
Creativity and innovation	There is a strong conviction among the vast majority of agencies doing PBMC that this approach fosters creativity and innovation.
Risk	Approximately three-quarters of agencies doing PBMC try to shift much or all of selected risks onto the contractor. These risks include motor vehicle accidents, material quantity fluctuations, and high prices for high-priced items.
Legal authority	Only one-third of those agencies that are doing PBMC required special legal authority.

- Innovation will be the most significant under long-term, performance-based, lump-sum agreements with selection based predominantly on best qualifications.
- The client will experience a perceived loss of control and flexibility.
- Three ways to monitor contractor performance have been observed and each has different implications. First, the contractor can monitor itself. This approach requires a strong bond of trust with the contracting agency and is generally the least expensive. Second, the contracting agency can monitor the contractor's performance. Agencies using this approach believe they can observe contractor performance effectively and have a good deal of control. Third, an independent third party can monitor the contractor. This method provides the most objectivity but is the most expensive.
- A program plan that lists upcoming performance-based procurements is valuable for alerting qualified contractors to bidding opportunities. This could be part of a long-term procurement strategy that sends a message to industry.
- Develop criteria for prequalification of contractors and use the criteria to identify a suitable number of competitors.
- Share risks in an equitable manner; shift risks appropriately—the contractor should not bear all the risks.

- Even though an executive or legislative mandate to downsize does not motivate the decision to use PBMC in the first place, pressures to downsize may build as more maintenance work is outsourced.

EVOLUTION TOWARD CONTRACTING BASED ON CUSTOMER-DRIVEN OUTCOMES

PBMC is the most recent stage in the evolution of maintenance contracting. The focus of PBMC on end results is not unique to highway maintenance. For example, major efforts are occurring to explore and promote performance-based construction contracting (Robinson 2007). The federal government, as discussed in the next chapter, has used performance-based service contracting for decades and is aggressively encouraging its wider use by federal agencies. In the private sector, performance-based contracting is accomplished through service-level agreements, which have also been used for a long time.

In highway maintenance, the progression has been to first move from performing work with just in-house staff and tracking resource costs (labor, equipment, and materi-

als) to outsourcing part of the maintenance program through contracts based on unit prices (dollar per unit of accomplishment of an activity). The most recent evolution of maintenance is to focus on value per dollar, in which case value is represented by customer-oriented performance indicators. Put differently, maintenance has changed as follows:

- From being internally focused to externally focused
- From contracting based on unit prices to contracting that provides incentives to achieve performance standards
- From inputs to outputs to outcomes important to road users.

Figure 4 summarizes this evolution.

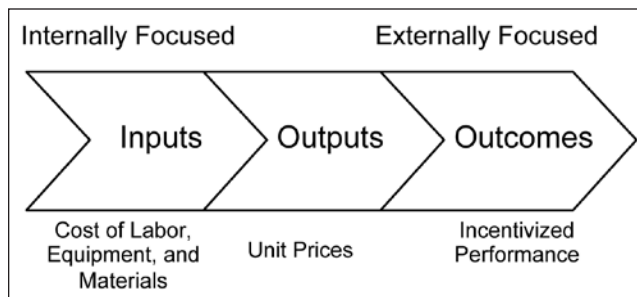


FIGURE 4 Evolution of maintenance contracting toward PBMC.

CHAPTER THREE

INSIGHTS FROM LITERATURE

As stated in the introductory chapter, a NCHRP synthesis project draws on two primary inputs. One is the literature on the topic and the other is one or more surveys. This chapter is organized in four parts, each based on the literature:

- An overview of international experience with PBMCs
- An overview of domestic experience
- Federal experience and guidance regarding performance-based contracts; and
- Information from the literature that provides insights regarding the basic steps of PBMC.

The previous chapter sought to provide an overview of PBMC and address most of the important issues. Perhaps none is as important as the accumulated evidence on whether PBMC results in value for money. Whether a cost savings has resulted from PBMC has been particularly contentious, partly because of the methodological challenges in determining whether PBMC is less costly than in-house staff doing the work or outsourcing based on unit prices.

Regardless of the evidence, politicians, interest groups, managers, and staff often hold strong views regarding the desirability of outsourcing, including PBMC. Keeping an open mind and carefully examining past and accumulating evidence in North America and around the world will help maintenance organizations make better decisions regarding PBMC. A reader can draw different inferences depending on whether he or she focuses on one case study or on many. This chapter includes numerous case studies from the literature that illuminate different facets of performance-based contracting, including whether PBMC resulted in improved LOS and cost savings.

HISTORICAL CONTEXT OF PERFORMANCE-BASED MAINTENANCE CONTRACTING

Figure 5 provides a brief overview of the evolution of PBMC from its early roots to its current role. In the United States, DOTs became concerned in the late 1960s and throughout the 1970s with better managing their maintenance programs. Many DOTs implemented the first generation of maintenance management systems. These systems used information concerning inputs (labor, equipment, material, and costs) and outputs (accomplishments) to increase the maintenance pro-

ductivity of specific activities (Roy Jorgensen Associates 1972; Markow et al. 1994).

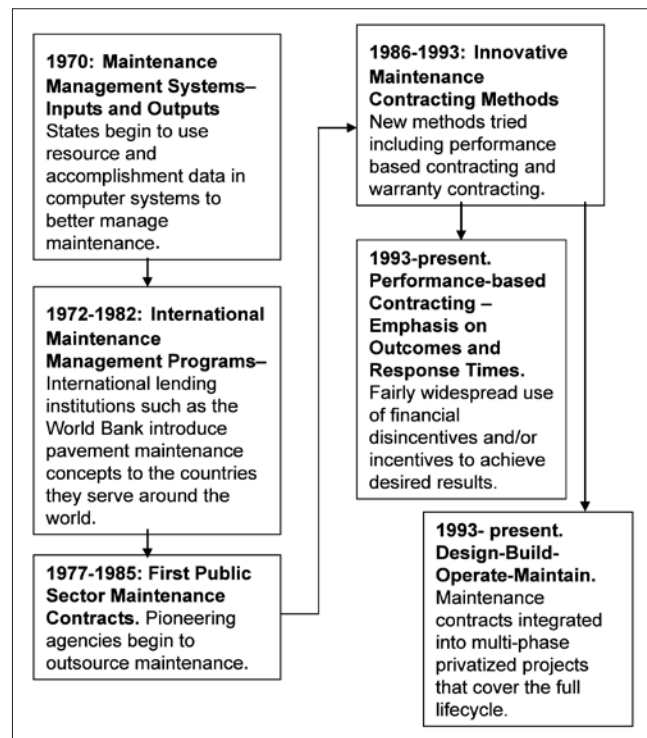


FIGURE 5 PBMC in evolution of outsourcing (Source: Adapted from Segal, Moore, and McCarthy 2003).

At roughly the same time, international lending institutions such as the World Bank helped developing countries make the best use of loaned funds applied to the highway sector. The World Bank developed increasingly sophisticated tools for decision support. Development of the Highway Design and Maintenance Standards Model (HDM) was instrumental in formulating maintenance and capital programs that made effective use of limited funds (Watanatada et al. 1987).

States began outsourcing in the 1970s, and the first performance-based contracts occurred in the late 1970s. Interest in new approaches to contracting burgeoned with the formation of the TRB Task Force on Innovative Contracting, an outgrowth of the first Strategic Highway Research Program (*Research Circular 386* ... 1991). In the following years, many states, provinces, and countries entered into perfor-

mance-based maintenance contracts. The role of PBMC in public–private partnerships, such as concessions and multi-phase highway projects (for example, DBOM), has come to be fully appreciated (Pakkala 2002, 2007).

INTERNATIONAL EXPERIENCE

Canada

In Canada, the development of performance-based contracts for road maintenance started in the late 1980s and early 1990s. British Columbia piloted the first PBMC in 1988 (Zietlow 2005a). Performance standards still leaned toward required work procedures rather than outputs or outcomes. Today, British Columbia uses performance-based contracts to maintain 100% of its provincial highways (Stankevich et al. 2006).

British Columbia

British Columbia embarked on PBMC as part of a program of extensive and rapid privatization governed by a number of principles and policies. The private sector would deliver services if it is more efficient and the public interest is not adversely affected, and no contractor can hold an interest in more than three maintenance areas. Government employees were given a number of options: resign, transfer to a position in another part of government, accept early retirement, or accept employment with firms awarded the maintenance contracts. About 2,300 employees chose employment with successful contractors, and relatively few picked the other options. The government sold off its equipment, so there was no turning back (Ribreau 2004).

Since 2003, British Columbia has made lump-sum awards for performance-based maintenance contracts with 10-year performance periods. The contracts address maintenance and repairs and do not include resurfacing, rehabilitation, and reconstruction. The services include surface maintenance, winter maintenance, drainage, landscaping, structures maintenance, sign work, emergency maintenance and repairs, and fixing damage to government property. A variety of work is quantified and serves as the basis for performance measurement and incentives. Performance standards are proactive and customer-oriented. The transportation agency does not prescribe the methods for doing work. Each month contractors receive one-twelfth of the annual lump-sum award provided that all performance standards are met; otherwise, deductions occur.

A qualitative conclusion is that the LOS are at least as good as they were before embarking on the performance-based contracts (Pakkala 2002). The public appears satisfied with the outcomes and the role the private sector is playing in maintaining the roads (Stankevich et al. 2006).

The cost savings for the 10-year, lump-sum, performance-based contracts has been estimated at 10% (Stankevich et al. 2006). Pakkala (2002) asserted cost savings, but no quantitative estimate was provided. A regression analysis performed on a very small sample and including a statistically insignificant variable suggested that costs actually increased (Stenbeck 2007).

Most of the former government employees have fared well working for private contractors (Stankevich et al. 2006). However, the published literature reviewed does not provide data or quantitative analysis to support this assertion.

Alberta

In the province of Alberta, PBMC was an outgrowth of a premier's initiative to reinvent government. The Alberta Infrastructure and Transportation Agency divided the province into 30 MCAs. Then the agency began outsourcing maintenance based on unit price (Pakkala 2002; Lali 2007). Originally a contractor was limited to working in three MCAs but is now allowed to work in seven. Substantial effort is devoted to ensuring that both competition and contractor capacity will be adequate. Contractor performance is judged against target LOS. Service levels include both technical criteria and response times. Failure to meet the contract performance criteria results in penalties.

In Alberta, the contract term is 5 years with a renewal term of 1 to 3 years. Price receives the majority of the weight in the contractor selection criteria (Stankevich et al. 2006).

In Alberta, the original objective was to provide a LOS that was at least equal to the LOS in-house maintenance staff achieved but at a lower cost (Bucyk and Lali 2005).

The Alberta Infrastructure and Transportation Agency will not disclose information on the LOS contractors achieve. This information is used to evaluate contractor performance and is an important factor in making contract awards.

Table 8 shows various estimates of cost savings and cost increases in Alberta.

Ontario

The Ontario Ministry of Transportation (MTO) has defined Area Management Contracts that cover 60% of the provincial road network. Performance-based maintenance contracts are 95% lump-sum and contract terms range from 7 to 9 years (Skinner 2007). The contracts include all routine maintenance such as pothole repair, vegetation management, bridge maintenance and cleaning, electrical work, and line painting. Other types of work addressed include winter maintenance, patrolling to conduct visual inspections, and emergency assistance to deal with accidents and spills. Maintenance

performance standards include both outcome and time-based performance criteria. Failure to meet the standards can result in penalties. Over time, the duration of the contract period has been increasing gradually and the number of maintenance activities has grown (Stankevich et al. 2006).

One source indicates that Ontario has experienced better LOS; the network quality is at least as good as it was before the performance-based contracts. No quantitative information was offered to support this assertion (Pakkala 2002). A knowledgeable staff member of the MTO said that information on the effect of contractors on LOS is not generally published (S. Skinner, personal communication, May 2007). As to cost savings, one of the sources stated that the MTO experienced some cost savings but did not provide backup information (Pakkala 2002).

was responsible for overseeing the pilot projects. Oversight responsibilities included inspection, prioritization of needs, definition of work, design of treatments, work management, and reporting, among other things. The exact same documentation and reporting procedures were used in each pilot. Next the RTA engaged a maintenance contractor and the in-house forces to maintain their respective 100 km sections of road (Stankevich et al. 2006). The RTA determined that, during the first year, the private entity was able to achieve, relative to the state forces, a 16% savings in costs, a 22% improvement in productivity, and a 13% improvement in the condition of assets (Segal et al. 2003).

These findings encouraged New South Wales to seek bidders and award a 10-year, \$130 million performance-based contract covering all maintenance activities for 450 km of

TABLE 8
COST SAVINGS OF PERFORMANCE-BASED MAINTENANCE CONTRACTS IN ALBERTA, CANADA

Contract Description	Source	Cost Savings
Two rounds of tenders of hybrid contracts eventually covering 100% of provincial roads in 30 Contract Maintenance Areas (CMAs)	(World Bank 2006)	5% savings for first round of tenders; 25%–35% savings for second round of tenders
	(Pakkala 2002)	Clients receive some cost savings (did not provide any quantitative estimates or supporting data)
	(Bucyk and Lali 2006)	An independent KPMG report stated there were cost savings based on tendering into 17 CMAs: a 28% reduction in cost between the new contracts (year 2000) and the old contracts (prior to 2000), which translates into a reduction in unit prices to \$3,705/km from \$5,117/km, representing a total annual cost reduction of \$26,419,932.
Whole province	(Stenbeck 2007)	Included Alberta in a regression analysis of change in costs per kilometer owing to PBMC for southern Canadian provinces, Washington State, and Sweden. Determined that PBMC resulted in an increase in costs for all these jurisdictions. (See text for discussion of validity of this result.)

Note: The base against which the cost savings are estimated is often not stated in the source.

Australia

Australia is composed of six states and two territories, a number of which have been among the world leaders in using performance-based maintenance contracts. One of the first jurisdictions to try this type of contract was New South Wales. In 1990, this state began a comparative study of two 100 km pilot projects in Sydney. According to the World Bank, the objective of the study was to determine the feasibility of contracting road maintenance and to estimate differences in cost, quality, and responsiveness between a contractor and the RTA's workforce (Stankevich et al. 2006). State forces performed the maintenance work in one pilot project and a private contractor conducted the maintenance work in the other. Results also were compared with work done by the in-house force. The RTA of New South Wales first awarded a management contract to a contractor that

urban roads (or 1,900 lane-km) in Sydney. The most important performance criteria were average roughness and cracking. The World Bank reported a 13% improvement in condition accompanied by a cost reduction in the 20% to 30% range, but it is not known over how many years of the contract these results apply. The bid price was 25% lower than estimated (Stankevich et al. 2006). The Reason Public Policy Institute reported that since New South Wales started this performance contract, roadway condition has improved approximately 15% and there has been a 35% cost savings (Segal et al. 2003).

Since then several new contracts have been let in New South Wales, Tasmania, and Southern and Western Australia. A number of them are hybrid contracts, in which some of the maintenance is paid based on both quantities and performance standards (Zietlow 2005a). Table 9 shows estimated cost savings for various jurisdictions throughout Australia.

TABLE 9
COST SAVINGS FROM PBMCs IN AUSTRALIA

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

Note: The base against which the cost savings are estimated is often not stated in the source.

TABLE 10
COST SAVINGS FROM PSMCs IN NEW ZEALAND

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

Note: The base against which the cost savings are estimated is often not stated in the source.

New Zealand

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

both method and performance specifications. A large number of the performance standards are expressed in terms of intervention times. The term of the hybrid contracts is only 5 years (Stankevich et al. 2006).

Industry experts have asserted that these PSMCs have resulted in improved maintenance service and road quality. The general manager of Transit NZ reported that better services were delivered. It is unclear whether this statement applies to a hybrid contract (with both performance and method specifications) or to a long-term performance-based maintenance contract. An expert on PBMC wrote that there were pronounced improvements in the quality of service, bumps, skid resistance, signs, drainage systems, and market posts for a well-known performance-based contract (Pakkala 2002).

Various sources have consistently reported cost savings for New Zealand's performance-based contracts. Example statements appear in Table 10.

United Kingdom

The U.K. Highways Agency is responsible for 8,850 km of the most strategically important part of the nation's highway network. This portion of the highway system amounts to only 4% of the total roadway miles in the United Kingdom, but it carries 30% of the total traffic and 60% of the truck traffic.

The United Kingdom implements four models for road maintenance, ranging from pure method-based to pure outcome-based with different levels of flexibility. Maintenance currently occurs under three different models, but a fourth, which has a financing component, is being developed. In one model, the Highways Agency enters into a contract with a consultant, the Managing Agent whose responsibilities include providing advice on procurement, procuring the Term Maintenance Contractor (TMC), providing a long-term focus, performing engineering, and assisting in strategic matters including promoting innovation. Once the Highways Agency and TMC have entered into a contract, the Managing Agent provides instructions to the TMC regarding what maintenance work to perform. Under a certain threshold, the TMC may perform rehabilitation work and upgrades.

Under a second model, a Network Board is established to provide further strategic direction, strengthen partnering, monitor highway improvements, and perhaps resolve conflicts or complaints.

The third model is administratively the simplest and transfers management of the network to a Managing Agent contractor while creating a Network Board to provide strategic direction.

Performance-based maintenance contracts are known as Managing Agent Contracts (MAC) in the United Kingdom. These contracts incorporate performance specifications to increase efficiency and effectiveness, allocate responsibility and risk between the client and the contractor, foster innovation, and focus the attention of the contractor on outcomes. Some important characteristics of MACs are as follows:

- Increased outcome orientation
- Lump-sum and unit prices as a basis for payment
- Strengthened partnering
- Emphasis on continuous improvement
- Focus on life-cycle costs
- Better risk management
- Supply chain management (Pakkala 2002; Harding 2005).

Little is published or easily accessible regarding changes in LOS or costs regarding PBMC in the United Kingdom. An article published in the proceedings of a seminar on the state of the practice regarding PBMC around the world reported that

it is difficult at this time to determine the effectiveness of the MACs. The author wrote that there is some overall evidence that service has improved with slightly reduced costs, particularly with respect to routine maintenance (Harding 2005).

Finland

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

As of approximately 2005, Finnra maintenance contracts were hybrids, 75% of compensation based on a lump-sum payment with adjustments for failing to meet performance criteria, and 25% based on unit price. The outcome-based portion of the contract, covered by the lump-sum payment, concerned winter and summer maintenance, minor bridge maintenance, gravel roads, vegetation management, and drainage and culvert maintenance, among other things. For example, intervention time and outcome specifications for winter maintenance required the contractor to respond to snow conditions within 2 hours, remove all snow to no more than 1 cm within a certain amount of time after it stops snowing, and achieve a measure of skid resistance of less than 0.3.

Of the remaining 25% of compensation for area contracts, payment is based on unit prices. Some of the types of work compensated in this fashion include the renewal of roadsides, replacing guardrails, and drainage repair.

Finnra enters into separate unit price contracts to address lighting, road markings, traffic signs and signals, resurfacing, and rehabilitation (Stankevich et al. 2006).

The major documents about Finland's experience with PBMC do not contain quantitative information and trends regarding changes in LOS (Pakkala 2002, 2007). Table 11 summarizes estimated cost savings from some key sources.

TABLE 11
COST SAVINGS FROM PBMCS IN FINLAND

Source	Savings
Finnish Road Enterprise (Pakkala 2005)	Cost savings analyzed at 7% to 10% for 3-year contracts and 13% for 7-year contracts
World Bank (Stankevich et al. 2006)	7% to 10% for 3-year contracts and 13% for 7-year contracts; the current price level is 50% to 60% of the price level when Finnra was using its own labor and equipment to do maintenance
World Bank Transport Note TN-27 (Stankevich et al. 2005)	30% to 35%; about 50% less cost/km

Note: The base against which the cost savings are estimated is usually not stated in the source.

Latin America

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

Argentina

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

Argentina's national system of roads totals 38,744 km, of which 30,912 km are paved and 9,508 are concession toll roads. In 1995, Argentina launched a series of performance-based maintenance contracts covering about 3,600 km of these national roads. The government selected paved roads in fair to good condition for 11 maintenance contracts, each varying from 105 km to 536 km for a total of US \$650 million. Contracts were lump-sum and payments were made each month according to an amount per kilometer (based on equivalent liters of gasoline to account for inflation but expressed here as dollars/kilometer/month). The contracts were for 2 years and were renewable. Three inspections, based on a sampling process, occurred once per month. If one or more deficiencies was found with regard to performance targets—both technical specifications and response times—the road agency made deductions from payments in accordance with a table of penalties. Performance standards addressed specific measures concerning ride quality, safety

features, and aesthetics including vegetation. Penalties were imposed gradually to give the contractor an opportunity to address the deficiency, but would reach 100% of the penalty if the problem was not redressed by the third inspection at the end of the month.

These kilometer/month performance-based maintenance contracts were judged to have worked well. The average cost of routine maintenance was \$175/km/month and penalties resulting from 600 instances of noncompliance totaled only \$300,000, approximately 1% of the value for all the contracts (Cabana et al. 1999).

The kilometer/month contracts were followed by a new and innovative contract designed for combined rehabilitation and maintenance of paved roads. This new contracting process, CREMA, unfolded in two phases. In the first phase, CREMA required the contractor to rehabilitate and then maintain a network of 11,818 km of nonconcessioned roads for five years for a lump-sum amount. Each contract covers contiguous segments with lengths ranging from 100 km to 300 km and specifies the road sections that require rehabilitation. Contracts tend to exceed 10 years. A minimum overlay thickness was specified to ensure a positive net present value given a 12% discount rate. About half the contract funds were paid to the contractor during the first year to cover the rehabilitation costs and the balance was paid as a lump-sum spread equally over 48 months. Deductions for failing to satisfy both technical and timeliness standards were imposed. The technical performance standards pertained to visual deterioration, potholes, cracks, rutting, blockage of drainage systems, friction, and deflection (Cabana et al. 1999).

The second phase of CREMA addressed 8,200 km of nonconcessioned roads under combined rehabilitation and maintenance contracts totaling \$550 million. Upon completion of the original rehabilitation work, contractors were required to maintain the roads in accordance with technical and timeliness specifications as in CREMA Phase I. These roads were in worse condition than those addressed in the first phase. Thus, it was necessary to rehabilitate a higher percentage of roads—in the range of 65% to 70% in Phase II compared with 40% in Phase I. In Phase II the contractor was required to perform rehabilitation using thicker overlays, more in line with the optimal thickness determined by the World Bank HDM model. Also in Phase II, the period in which rehabilitation could occur was increased from 12 to 24 months or longer (Stankevich et al. 2006).

Under another contracting approach, to obtain additional funds to finance the rehabilitation and maintenance work of medium- and low-volume roads, the government awarded 12-year concessions that permitted contractors to collect tolls. The government also made payments to the contractor for additional costs (Segal et al. 2003).

Because the first phase of CREMA performance-based contracts began with rehabilitation followed by maintenance, it had a significant effect on asset condition. The percent of roads in good to fair condition increased from 59% to 94%. The percent in critical to poor condition declined from 41% to 6%. Also, roughness measurements deteriorated at a slower rate than predicted by the HDM (Stankevich et al. 2006).

A report of the Reason Public Policy Institute states that Argentina has achieved reduced costs of maintenance, better LOS, new capital investment in the highway network, and a reduction in the government's maintenance workforces; it also largely eliminated corruption in highway maintenance and rehabilitation (Segal et al. 2003). However, an international expert on PBMC wrote that until now only the contracts in Australia, New Zealand, and the United States have reported substantial cost savings, whereas in Latin America no comparable cost analysis has occurred (Zietlow 2005). A more recent resource guide of the World Bank concluded that the first phase of CREMA was determined to cost 16% to 20% more than conventional contracting, but adjustments were not made to put the highway agency and contractors on a level playing field. An analysis after the fact suggested the rate of return on rehabilitation and maintenance work was 60% calculated at a 12% discount rate. The lump-sum contract arrangement during Phase I virtually ensured no overruns except for force majeure events. Annual costs never exceeded the lump-sum amount by more than 3%. Finally, the 60 Phase I CREMA contracts were judged to be financially attractive to the private sector, because only one contract was cancelled (Stankevich et al. 2006).

Other conclusions of the World Bank resource guide regarding Phase I of the CREMA include the following:

- This lending institution was able to disburse its funds much more quickly to rehabilitate and maintain the highway sector.
- Lump-sum contracts essentially eliminated cost overruns.
- The government was forced to bear long-term obligations to pay the contractors.
- Supervision costs fell sharply because the contractors supervised themselves.
- The relatively simple set of performance indicators permitted a small inspection team to monitor the contractors.
- The performance specifications, which focused on outcomes, fostered innovation.
- The likelihood of poor quality rehabilitation work was minimized because of the contractor's responsibility to maintain the roads over the next 4 years and the penalties for failing to satisfy the performance standards.
- Capital improvement needs were estimated to decline by 30% (Stankevich et al. 2006).

Uruguay

Beginning in 1996, the Ministry of Public Works introduced performance-based contracts for the maintenance of Uruguay's national highway network. There were essentially two types of contracts; one concerned just routine maintenance, and the other involved initial rehabilitation followed by periodic and routine maintenance.

The first type of contract (for routine maintenance) gave the employees of the ministry an opportunity to start their own contracting businesses. At the same time, the ministry was able to reduce the number of its employees. To reduce the anxiety of staff and provide an inducement to work for private contractors, staff could return to the ministry if the contractor failed during the first year. The contracts were all successful. More staff desired to participate in the new contracts than the contracts were able to absorb.

Because the new contracting approach worked so well, the ministry carefully planned and piloted a second type of contract: a performance-based contract similar to Argentina's that involved both rehabilitation and periodic and routine maintenance. Rehabilitation occurred on selected sections of highway before maintenance occurred. By the start of 2000, more than 40% of the national road network was being maintained under 5-year, performance-based maintenance contracts (Zietlow 2005b).

The first performance-based maintenance pilot in Uruguay resulted in an improvement by two contractors in road conditions from 1996 to 1998. The first contractor increased roads in very good condition from 0% to 25% and reduced roads in regular condition from 40% to 15%. Roads in good and bad condition remained unchanged at 60% and 0%, respectively. The second contractor increased roads in very good condition from 23% to 37% and those in good condition from 13% to 46%, and reduced roads in regular condition from 64% to 17%. The percent of roads in bad condition remained unchanged at 0% (Stankevich et al. 2006).

City of Montevideo

In 1996, as Uruguay started transforming its road contracting process, Montevideo commenced its first performance-based contract for nearly 140 km of its city roads. The city entered into a 3-year contract with a 3-year extension. Portions of the network needed initial rehabilitation. Montevideo paid the contractor based on unit price for the rehabilitation work. During the 3-year extension, the contract called for cutting monthly payments by 40% because of the rehabilitation work that previously occurred.

The city defined performance standards, response times, and penalties for noncompliance for pavements, shoulders, and drainage systems. Because road conditions at the start

of the contract were significantly below the performance standards in the contract, the contractor had between 3 months and 12 months to bring the assets up to the required standards.

Because the first contract proved to be successful, Montevideo pursued two additional contracts, one involving gravel roads (Zietlow 2005b).

Shortly thereafter, other Latin American countries, such as Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, and Peru, also started adopting or planned to adopt a performance-based approach.

Chad

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

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

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

DOMESTIC EXPERIENCE

Within the United States, two evolutionary paths have resulted in increased performance-based contracting. The first is growing use of PBMC by state DOTs. The motivation for adopting PBMC includes governor and legislative direc-

tives, authorizing legislation that promotes public-private partnerships, downsizing, and a fixed level of staff faced with rapidly growing maintenance needs. Other reasons include a focus on customer-oriented outcomes, potential cost savings, the possibility of shifting more risks onto the contractor, and achieving increased predictability of future maintenance expenditures.

The other evolutionary path consists of the steps federal agencies have taken to implement performance-based contracting. In response to a variety of legislation and regulatory changes, the amount of performance-based contracting has increased rapidly among federal agencies, including the U.S. Department of Defense (DOD) and the U.S. DOT. Indeed, the Procurement Executives Council and the Office of Acquisition Management of the U.S. Department of Commerce set a goal that by 2005 at least 50% of all eligible federal contracts be performance-based service contracts (Hyman 2003; "Increasing the Use of Performance-Based Service Acquisition" 2005).

The remainder of this section focuses on the experiences of state DOTs with PBMC and also addresses performance-based warranty contracts.

Virginia

In 1995, the legislature of the Commonwealth of Virginia enacted the Public and Private Transportation Act. The law stated that a private entity could submit a proposal to any responsible entity within the state, including the Virginia DOT, to design, construct, finance, and operate facilities for any mode of transportation. The public entity was required to evaluate and decide whether to accept the proposal after it posted a description of the proposal for public comment. Under the legislation, VDOT also could solicit public-private partnerships (Virginia General Assembly 1995).

Not long after the enactment of the Public and Private Transportation Act, a construction and maintenance firm submitted an unsolicited proposal to VDOT to maintain parts of I-95 and I-81 and all of I-77 and I-381, totaling 251 miles (404 km), representing 20% of Virginia's Interstate highways. In December 1996, VDOT awarded the firm a performance-based contract to maintain this portion of Virginia's Interstate system. The value of the contract was \$131.6 million and the initial term of the contract was for five and one-half years, with an option to extend the contract for another five years.

This was a lump-sum contract. There were no deductions for failing to meet performance targets and no liquidated damages expressed in terms of LOS.

The contractor paid a company that specialized in asset management to develop a maintenance management system

that would monitor achievement of performance targets and serve other purposes such as issue work orders. Although the contractor monitored its own performance, VDOT conducted an annual audit and issued a report card noting achievement of the performance targets.

The contractor was responsible for nearly all types of assets and features from fence to fence, including repair and rehabilitation of pavements, structures, and tunnels; drainage such as culverts and ditches; roadside vegetation management; and guardrail, signs, and fences. In addition, the contractor was responsible for snow and ice control as well as incident response (Segal et al. 2003; Stankevich et al. 2006).

The contractor was able to achieve the LOS targets for more than 90% of the items rated. In 2001, VDOT renewed the contract for five years. Figure 6 presents the annual report card for VDOT's performance-based contract. The evaluation was performed by an independent third party. The report card shows that the contractor received a grade of A for shoulders, roadside, and drainage-related maintenance on all mainline sections but received a couple of B's and a C regarding traffic. In contrast, control sites that VDOT maintained generally received B's and C's.

soundness of the analysis could not be verified ("Review of VDOT's Administration ..." 2001). Another VDOT study concluded that the contractor provided the interstate maintenance for 25% less than the state could (Hall 2005). Also, the contractor prepared an estimate of savings in terms of cost per mile: \$22,400 for the contractor compared with \$29,500 for VDOT (Hall 2005). Virginia Tech ultimately found that cost savings ranged from \$6.5 million to \$22 million, the result of a sensitivity analysis based on varying the overhead rate of the contractor relative to VDOT, after escalating costs according to a price index. Virginia Tech's approach began with comparing bid tabs, because the contractor subcontracted 80% of the interstate maintenance work (De La Garza and Vorster 2000). JLARC acknowledged that the Virginia Tech study might shed light on the cost-effectiveness of this contract. However, JLARC expressed concern about the narrow scope of the study and believed that the findings might not prove conclusive ("Review of VDOT's Administration ..." 2001).

Washington, D.C.

In 1998, in association with FHWA, the District of Columbia Department of Public Works awarded a 5-year \$69 million

Sites	Sections of Interstate	Shoulders		Roadside		Drainage		Traffic		All Groups	
		Grade	Confidence Level	Grade	Confidence Level	Grade	Confidence Level	Grade	Confidence Level	Grade	Confidence Level
VMS SITES	I-95 Mainline (Section 1)	A	95%	A	95%	A	95%	B	95%	A	95%
	I-81 Mainline (Section 2)	A	95%	A	94%	A	95%	A	95%	A	95%
	I-77 Mainline (Section 3)	A	95%	A	94%	A	95%	A	95%	A	95%
	I-381 (Section 4)	A	95%	A	95%	A	95%	A	95%	A	95%
	I-95 Ramps (Section 1)	A	95%	A	95%	A	95%	C	95%	B	95%
	I-81 Ramps (Section 2)	A	95%	A	95%	A	95%	A	95%	A	95%
	I-77 Ramps (Section 3)	A	95%	A	95%	A	95%	B	95%	A	95%
	All VMS Sites	A	95%	A	95%	A	95%	A	95%	A	95%
VDOT CONTROL SITES	I-95 Mainline (Section 5)	A	95%	A	95%	A	95%	C	95%	B	95%
	I-81 Mainline (Sections 10 and 12)	A	95%	B	94%	C	95%	A	95%	B	95%
	I-66 Mainline (Section 6)	A	95%	B	95%	A	95%	B	95%	A	95%
	I-64 Mainline (Sections 7, 8, and 9)	A	95%	B	94%	B	95%	B	95%	B	95%
	I-581 Mainline (Section 11)	A	95%	A	95%	C	95%	A	95%	B	95%
	All VDOT Control Sites	A	95%	B	94%	B	95%	B	95%	B	95%

FIGURE 6 2005 report card for VDOT performance-based maintenance contractor (Source: Bryant 2007).

VDOT projected cost savings of \$23 million before it embarked on its first round of PBMC on Virginia's Interstate highways (Segal et al. 2003). According to the Joint Legislative Audit Review Committee (JLARC) of Virginia's General Assembly, VDOT's cost savings were based primarily on estimates and projected costs that were compared with future contractor payments. JLARC staff stated that documentation did not exist to support the savings and the

performance-based contract to a contractor for maintenance of 75 miles of the NHS within the District. This was the first performance-based contract of its type in an urban area of the United States. Contract selection was based on best value. Payments to the contractor included incentives and disincentives, which depended on achievement of performance standards. The contract covered the following (Robinson and Raynault 2005):

- Pavement structures
- Drainage
- Roadside
- Traffic safety such as guardrail and attenuators
- Roadside cleaning
- Traffic safety
- Bridges
- Curb and gutter
- Tunnels
- Roadside vegetation
- Snow and ice control
- Pavement markings
- Traffic signs
- Highway lighting
- Miscellaneous (e.g., weigh-in-motion and pedestrian bridges).

Five LOS were defined for roughly 170 maintenance elements grouped in various categories. Performance measures reflected both LOS for assets and operations and response times to address needed work. Performance targets or standards were set between Levels 3 and 4 and transformed to a scale of 0 to 100. The contractor was responsible for monitoring its own performance daily based on its QC plan.

Each month an independent third party, along with District and contractor staff, inspected each maintenance element. The independent third party provided for each element a rating of poor, fair, or good. Then a composite score was calculated. This complementary grading system was developed to facilitate communication with stakeholders regarding the outcomes that were being achieved. Poor performance received a 0, fair performance received a 50, and good performance received 100. If the contractor equaled or exceeded all performance standards, then its score would be 100 (Robinson and Raynault 2005).

At the end of each year, an objective, comprehensive evaluation was conducted by the independent third party. The contractor was able to earn a variable award fee for excellent performance.

A public policy institute wrote that, from the time the District entered into its contract with the contractor, the District observed significant improvements in the condition of the road assets on the portion of the NHS maintained under the performance-based contract. After the first year, performance rose from the high 20s to the low 80s (out of 100). Based on input provided by a field engineer in FHWA's Office of Asset Management, the public policy institute observed that this improvement was attributable in part to the specialization achieved by subcontracting to smaller companies or companies that the contractor created for an area of maintenance (Segal et al. 2003).

The objective of the project was to significantly improve asset condition and maintenance operations on the NHS. Cost savings was not an objective in light of the infusion of funds required to significantly improve the LOS. Indeed, none of the published sources examined in this study offered evidence of cost savings regarding the District of Columbia's experience with PBMC.

Texas

The Texas DOT (TxDOT) initially performed most of its maintenance work using in-house staff. Its outsourcing contracts involved just a limited number of single maintenance activities. However, over time, the legislature enacted laws requiring TxDOT to outsource an increasing amount of maintenance. A 1989 bill required TxDOT to contract 25% of its routine maintenance, provided that the practice was cost-effective. In 1991, the Texas legislature raised the requirement for maintenance contracting and directed TxDOT to increase maintenance contracting to 50% by 1996, once again providing that outsourcing was cost-effective. The legislature required TxDOT to set targets for each of the districts to ensure compliance was met by 1996. As a consequence of this legislative direction, TxDOT embarked on two total maintenance contracts and developed a performance-based contracting program for its rest areas (Graff 2001).

Total Maintenance Contracts

In 1999, TxDOT entered into two performance-based maintenance contracts unprecedented in their size, scope, and risk. These contracts involved sections of Interstate highway with some of the heaviest traffic in the state. The first involved 120 miles of I-35 in the Waco District and the second was 60 miles of I-20 in the Dallas District.

The impetus for these contracts was a presentation on the VDOT asset management contracts at the Texas Quality Initiative held in 1998. Partnering was a key to successfully initiating these total maintenance projects. The collaborative effort of the department and potential bidders was essential to calm fears about this novel endeavor and establish the performance measures and standards (minimum LOS) acceptable to all parties. Performance standards were developed for every type of maintenance and operations on these two sections of the Interstate. Selected types of assets and operations that were addressed included the following:

- Pavements
- Bridges
- Roadsides
- Traffic operations
- Traffic services
- Incident response

- Hazardous materials cleanup
- Emergency repairs.

Contractor responsibility included coordinating with local government and law enforcement officials. Contractors were also required to process damage claims and obtain disaster reimbursement from federal agencies.

To make before-and-after comparisons of performance of contractors and in-house staff, TxDOT developed a Maintenance Assessment Program. A LOS rating system similar to the process described in the *NCHRP Web Document 8: Highway Maintenance Quality Assurance* (Smith et al. 1997) was the key to the performance assessment process. This process so impressed upper management that it asked for an evaluation of the LOS of the whole Interstate system. The following is a description of the Texas Maintenance Assessment Program rating system:

Random 1.6-km (1-mi.) sections are rated every 16 km (10 mi.). Bridges are rated in a separate evaluation. Each element (for example rutting, failures, striping, signing, mowing, litter) is rated at each location on a scale of 5 to 1, where 5 is excellent—new or like new; 4 is good—no work needed; 3 is fair—minimum acceptable condition; 2 is poor; needs work; and 1 is failed. A 1 to 100 score is determined....Each element is given a priority multiplier depending on its relative importance based on the following priorities: safety, protect the investment, user comfort, and esthetics. The elements are then combined by multiplying the resulting scores in each component, and dividing by the maximum possible score. The components are combined to give an overall score (Graff 2001).

TxDOT developed detailed specifications, such as performance measures and standards, with the assistance of a large number of stakeholders, including headquarter maintenance personnel, districts, and potential bidders. This part of the process was essential to achieve consensus and ensure that the procurement documents would attract bidders.

TxDOT was concerned with a variety of risks and needed to develop a strategy to mitigate each one:

- Calming employee fears. Fears were calmed through good open communication and the professionalism of the potential contractors.
- Cost and insufficient competition. TxDOT believed that contractors for the PBMC could not provide services for lower costs than state forces and the traditional smaller contractors that had done much work in the past. However, the successful contractor's bid was below the department's estimate. Also, the successful contractor subcontracted much of the work to smaller contractors that historically did maintenance for TxDOT.
- Emergency response. The acquisition team put special emphasis on performance standards concerning emergency response.

The total maintenance contracts were awarded based on the low bid. Payment was made in accordance with the contract payment schedule that set out monthly payments in terms of a percentage of the contract award. The period of performance was 5 years with a possible extension of 3 years. Monthly payments were calculated by multiplying the winning contractor's lump-sum bid by the monthly payment schedule percentage and making any deductions dictated by contractor performance.

In addition to the benefits of lower bid costs than anticipated, TxDOT found the following additional advantages to its total maintenance contracts: less inspection was required; less documentation of quantities applied was needed because of the lump-sum nature of the payment, and the contractor was encouraged to be innovative because it was not tied to method specifications (Graff 2001).

What were the outcomes in terms of service levels of the total maintenance contracts? LOS initially declined on I-20 and I-35 and then started to rise (see Figure 8 in chapter 4) (Graff 2007). The contractor provided higher-quality snow and ice control than the agency previously did (*A Guide for Methods and Procedures in Contract Maintenance* 2002). Although a Washington State DOT white paper on outsourcing cited newspaper articles about poor contractor response to icy roads (Ribreau n.d.), the articles did not acknowledge that these were the worst ice storms in years. The contractor deployed its personnel and equipment; however, in numerous instances, equipment became stuck in traffic and could not get to the areas needing treatment (Segal and Montague 2004).

Rest Areas

As the year 2000 approached, Texas found that the condition of its 740 picnic areas and 102 rest areas had seriously eroded. The condition of buildings, grounds, pavement, water, and wastewater systems had deteriorated. To reverse this deterioration, TxDOT decided to let and enter into four 2-year performance-based contracts in each quadrant of the state to upgrade and maintain the rest areas. Performance-based maintenance contracts were valued at \$6 to \$8 million each. Upgrades involved new construction, reconstruction, major renovations, and possible conversion of some sites to truck parking.

To measure performance, TxDOT developed rating guides that provided pictures of acceptable and unacceptable conditions for every component of these facilities. Each contractor was required to submit an enhancement plan explaining the repairs or improvements necessary to bring each component up to an acceptable level or better. TxDOT established an evaluation process, a rating system, and a combination of incentive and disincentive payments to ensure that conditions improved and goals and standards were met. TxDOT conducts formal, unannounced inspections to keep subjectivity to a minimum.

Rating scores can range from 0% to 100%. At the beginning of the program, rest areas had scores that averaged 73% and ranged from 15% to 99%. TxDOT established a goal of increasing the average score across the state to 85%. Facilities with lower scores failed and scores of 85 or above passed. For each day that a contractor scored more than 92%, it received a 15% incentive payment of the normal daily pay. The incentive was paid until the facility's score fell below 92% in another evaluation. Incentives and disincentives were based on a rest area's overall score. Contractors that scored 84.49 or lower received deductions in daily pay according to declining thresholds. Failure to meet the rest area maintenance standards for two consecutive evaluation periods could result in an additional fine of \$5,000 per day.

After the first year of these contracts, TxDOT had paid incentives and assessed disincentives and deductions of nearly an identical amount of about \$246,000. Average statewide ratings of facility conditions increased from 73% before the performance-based maintenance contracts to 91% at the end of the first year (Sims 2004).

Florida

The Florida DOT (FDOT) has an extensive program of asset management involving PBMC. This program is termed "Asset Maintenance." FDOT entered into 22 Asset Maintenance contracts from July 2000 through November 2005. These contracts have a total value of \$672 million, an average of nearly \$100 million per year (Florida Department of Transportation 2006).

According to a description of FDOT's asset management program, PBMC includes planning, programming, administration, management, performance, and inspection of routine maintenance involving 6- to 10-year lump-sum contracts. Criteria for contract selection give 40% to technical considerations and 60% to price.

FDOT uses four types of asset maintenance-based contracts:

- Corridor contracts focused on limited access highways;
- Geographic (e.g., regional) contracts with multiple types of transportation facilities;
- Facility contracts focused, for example, on rest areas or weigh stations; and
- Fixed and movable bridges.

Performance-based contracts cover these maintenance activities, as well as specific contracts focused on such elements as aesthetics or drainage.

Among other assets and activities, performance-based maintenance contracts typically address the following (Florida Department of Transportation 2005):

- Mowing
- Signs
- Guardrail
- Pavement striping
- Replacement of raised markers
- Fence repair
- Shoulder maintenance
- Cleaning drainage systems
- Environmental compliance
- Incident response
- Natural disaster preparedness
- Inspection of bridges
- Highway lighting
- Motorist aid service patrols.

Contractors strive to achieve performance targets that are integral to a Maintenance Rating Program (MRP). Performance measures are grouped by five elements: pavement, roadside, traffic services, drainage, and vegetation and aesthetics. Each element includes unique characteristics; for example, the roadside element is composed of unpaved shoulder, front slope, slope pavement, sidewalk, and fence.

Each characteristic is measured against a set of standards outlined in the MRP handbook. The standards for certain characteristics vary by facility type: (1) rural limited access roads, (2) rural arterial roads, (3) urban limited access roads, and (4) urban arterial roads. Three times a year, each cost center evaluates 30 sample points for each of the 4 facility types. These evaluation results are used to calculate the annual MRP score; however, FDOT is moving more toward performing MRP evaluations on the contractor, rather than allowing the contractors to self-evaluate. FDOT has set to achieve MRP ratings of 70 for each characteristic, 75 for each element, and 80 overall. Failure to achieve the performance standards results in reductions in monthly payments.

FDOT has asserted that it has realized performance improvements and cost savings by transferring the responsibility for maintenance, daily management, and inspection of work to contractors (Florida Department of Transportation 2005).

Based on extensive time-series data on the state's MRP published on FDOT's website (Florida Department of Transportation 2000/2001–2006/2007), it is evident that FDOT's in-house staff and contractors, including those doing PBMC, have achieved service levels that generally exceed minimum performance standards in each maintenance area and on the four types of facilities rated.

FDOT indicated that it intended to further increase its Asset Maintenance program expenditures in 2009 to cover 40% of the entire maintenance program. The balance of the program will be 40% traditional contracts and 20% in-house contracts. Looking to the future, FDOT offers the following perspectives on possible expansion of asset maintenance:

- Pros
 - Potential for larger dollar savings
 - Reduced maintenance program administration
 - Further shared risk
 - Wider use of performance-based contracting
- Cons
 - More difficult to adjust contracting program should funding shortfalls occur
 - Less flexibility to adjust resources to immediate unplanned problems or issues
 - Industry may struggle to keep up with a significantly increased program
 - Potential reduction in FDOT contract funds for direct contracting with local governments, youth work experience groups, Respect of Florida, and so on.

Oklahoma

As a result of direction from the governor, in 2001 the Oklahoma DOT entered into two 5-year (renewed each year), lump-sum performance-based maintenance contracts with a combined value of \$36 million to perform routine maintenance in five counties in the Tulsa and Oklahoma City areas. Routine maintenance included such activities as pothole repair, sign repair, litter pickup, and snow and ice control. Legislators expressed concern that the DOT was pressing headlong into these contracts without examining the alternatives and the lessons learned from other states. About 7 months after the contracts were executed, the contractor terminated the contract for convenience. The parties sued each other, but then they reached a settlement. A careful examination of the circumstances revealed that the breakdown between the parties was due, at least in part, to flaws in the contract. There is agreement among those who have written about Oklahoma DOT's experience that a well-written performance-based contract with strong reporting and monitoring provisions is essential to success, and by implication, such a contract could have averted this failure (Ribreau et al. 2004).

SUMMARY OF SELECTED PERFORMANCE-BASED MAINTENANCE CONTRACTS

Table 12 presents key characteristics of selected long-term performance-based maintenance contracts in the United States, Australia, and New Zealand.

Warranty-Type Contracts

Warranty types of maintenance contracts require the contractor to guarantee the workmanship and materials of the service or product for a certain number of years, typically 1 to 3 years after work is completed. The contractor is required to obtain a warranty bond that protects the DOT from failures or substandard outcomes and ensures the agency that

the contractor will fix any problems. Warranties may combine method specifications with product-performance standards or focus on contractor performance, for example, in a contractor-performance-based warranty contract. Generally DOTs apply warranties to construction, reconstruction, and rehabilitation, but they have been used for maintenance. Warranty jobs are different from traditional contract jobs in two respects: (1) The contractor is responsible for maintenance work that may occur over the warranty period and (2) the contractor is free to use whatever materials and methods are deemed appropriate provided the state performance standards are met.

Aspen, Colorado

Aspen, Colorado, is a major tourist destination during both the winter and summer. Tourism drives the local economy. During the winter, ineffective and inefficient snow and ice control can impair accessibility. Summer road maintenance can also interfere with traffic. To avoid the disruption required to maintain and improve roads and to avoid deferring maintenance, in 1999, the city of Aspen decided to enter into a 15-year contract, with extension options and a product quality warranty. The contract covered both rehabilitation and maintenance on about 30% of the city's streets. One of the objectives of this contract was to encourage a strong relationship between the contractor and the city. Long-term contracts tend to encourage contractors to reduce life-cycle costs by performing quality work at the right locations at the right time. The contract also offered the contractor considerable flexibility to determine the best methods and materials to perform the work. The contractor developed an innovative approach to effectively develop, manage, and oversee aggressive work schedules.

Thus far, the city of Aspen is reputed to be highly satisfied with the contractor and the partnership that has emerged. Cost savings have been realized, work has been completed faster than before, the work has been high quality, and the contractor has limited the adverse impact on tourist travel. A key to success has been the identification and effective alignment of goals and incentives between the city and the contractor (Segal et al. 2003).

New Mexico

New Mexico Highway 44—redesignated US-550 in January 2000—consistently ranked among the most dangerous roads in the country. According to the New Mexico Traffic Safety Bureau, from 1992 through 1996, 36 people died and 264 were seriously injured in traffic crashes on NM-44. The Four Corners area, which includes the city of Farmington and San Juan County, had the fourth highest population, while having the ninth highest unemployment rate in New Mexico. Driven by concerns about public safety and the desire to provide economic development opportunities to the area,

then Governor Gary Johnson directed that construction and completion of the 118-mile, four-lane road be a high priority during his administration.

Traditional road design and construction methods used by the New Mexico DOT (NMDOT), formerly known as the New Mexico State Highway and Transportation Department, let it to bid projects in roughly 4- to 5-mile increments. This approach would have taken many years to upgrade the entire corridor. To accommodate the governor's directive, a new approach to road construction was required.

In July 1998, NMDOT entered into a lump-sum performance-based contract with a limited liability company with a well-known parent corporation to design, manage construction, and warrant NM-44 from San Ysidro to Bloomfield. The total cost of the project was \$323.83 million, which included \$46.82 million for project design and construction management, \$215 million for construction, and \$62 million for performance warranties.

The project involved reconstructing and widening 118 miles of roadway, rehabilitation or replacement of seven bridges, and replacement or extension of 393 culverts. The contractor subcontracted with firms to design the project and to provide construction management and QA.

The project was divided into four bid segments with NMDOT awarding each construction segment in accordance with state procurement regulations. The initial construction phase of the project was substantially completed in November 2001, less than 3.5 years after the initial contract was executed with the main contractor.

The project encountered significant problems, thus activating the warranty provisions. At the same time, the overall benefits of the project were determined to be positive. More than 300 locations were identified as not meeting warranty performance criteria, resulting in more than 180 task orders issued to repair these locations. Total expenditures as of early 2007 for the pavement and structures warranty reached \$8.03 million with \$161,000 expended on emergency repairs, \$1.22 million expended on the structures warranty, and \$6.65 million expended on the pavement warranty.

The Design Professional Services portion of the contract obligated the contractor to design the project in accordance with NMDOT and AASHTO guidelines as the minimum required design standards. This portion of the contract required the contractor to perform geotechnical subsurface testing to ensure that the roadbed and structures foundations met acceptable design standards. Although NMDOT reviewed the design provided by the contractor, contract terms provided that the NMDOT review did not relieve the contractor from full responsibility for the performance of the professional services in accordance with the standards, terms, and conditions of the agreement.

Additionally, the contractor warranty specified that for 3 years from substantial completion of the project, if design or construction management failed to meet standards, the contractor would perform any necessary corrective design and would be liable for the cost of repairs or replacement directly attributable to the failure. The contract specified that the contractor's liability on the professional services warranty would be limited to \$25 million.

TABLE 12
SELECTED LONG-TERM PERFORMANCE-BASED MAINTENANCE CONTRACTS

	Virginia DOT USA	Washington, D.C., DOT USA	Texas DOT, Waco, Tex., USA	New South Wales, Australia	Tasmania, Australia	New Zealand PSMC 001 NZ	Western Australia, Australia TNC 01
Begin Date	1995–1996	June 2000	Sept. 1999	1995	July 1998	Jan. 1999	Nov. 2000
POP	5.5 & 5 Years	5 Years	5+3 Years	10 Years	10 Years	10 Years	10 years
Cost	US\$ 131.6 M (first term) 2nd term renewed	US\$ 69.6 M (total)	US\$ 19.8 M (total)	AU\$ 20M per year	AU\$ 8 M per year	NZ\$ 75 M (total)	AU \$95.05M per year
Road Length	402 km	120 km	193 km	100 km	120 km	463 km	2120 km
Maintenance Activity	Maintenance rehabilitation*	Maintenance rehabilitation*	Routine maintenance	ALL	ALL	ALL	ALL
Type of Contract	Lump-sum	Lump-sum	Lump-sum	Lump-sum	Lump-sum	Lump-sum	Lump-sum
Performance Criteria	Outcome-based	Outcome- based	Outcome- based	Outcome- based	Outcome- based	Outcome- based	Outcome-based

Source: Pekka Pakkala (2002).

*With minor revisions.

NMDOT paid \$60 million for the 20-year pavement warranty and \$2 million for the 10-year structures (bridge, drainage, and erosion) warranty. The duration of the warranty agreement is limited to a specified time, number of equivalent single-axle loads (ESALs), or total expenditures, whichever occurs first. The pavement warranty is limited to 20 years of service life, 4 million ESALs, or \$110 million of total contractor expenditures. Therefore, beyond the \$60 million payments from the state, the contractor is at risk of an additional \$50 million in pavement expenditures, if necessary, to meet the terms of the warranty. The structures warranty is limited to 10 years of service life, 2 million ESALs, or \$4 million of total contractor expenditures. The contractor is at risk for an additional \$2 million in structure expenditures, if necessary, to meet the terms of the warranty. The pavement and structures warranties are therefore treated as two separate and distinct contracts and are secured by a \$114 million surety bond.

The warranties are divided into four segments (same as the construction segments), each of which is subject to expiration depending on the ESALs count for that segment. The contractor submits an Annual ESAL Calculation Report to summarize the cumulative amount of ESALs calculated from data obtained from three weigh-in-motion stations located at the beginning, middle, and end of the project. NMDOT is responsible for the weigh-in-motion station maintenance and data, and the contractor is responsible for calculating the number of ESALs.

The pavement and structures warranty portions of the contract state that the contractor will repair or replace any portions of the project that fail to meet specific objective performance measurement criteria. The pavement performance criteria establishes minimum acceptable criteria for various road conditions, including smoothness, rutting, cracking, bleeding, raveling, delamination, potholes, and depressions. The structures performance criterion establishes minimum acceptable criteria for various bridge, drainage, and erosion conditions.

Pavement and structures are inspected annually by contractor subconsultants to locate and identify areas that do not meet the performance criteria. An annual maintenance plan is prepared by the contractor summarizing the findings of the inspections and outlining a plan for maintenance and repairs for the next construction season. Deficiencies identified during the annual inspections are then repaired, bringing the problem areas back into compliance with the performance criteria.

NMDOT is responsible for nonpavement maintenance along the roadway, such as mowing, metal barrier repairs, snow removal, striping, and signage.

NMDOT elected to use a variation of a price agreement, the Job Order Contracting (JOC) method, in which the price agreement presents a comprehensive scope of work, with all anticipated bid items. Individual task orders or JOCs are issued to the contractor for a specific maintenance or repair task to be paid at the unit bid price amount for each applicable bid item. The JOC method differs from a conventional price agreement, which is typically confined to a specific service, such as striping or crack sealing, by providing for a wider array of construction and maintenance activities.

Although the project required significant corrective actions—180 task orders to conduct repairs at more than 300 locations not meeting warranty performance criteria—studies conducted on safety and economic impact found the project to be beneficial to road users. The motoring public has experienced shortened travel times, smoother riding surface, with a decrease in crash severity and average cost per collision. The economic expansion predicted in 1999 has not materialized.

Task order work has minimally affected the motoring public. Many of the task orders are erosion related, for which work is performed off the roadway. The majority of pavement task orders have required short-term lane closures involving mill and overlay or grinding operations. Longer-term lane closures necessary for full-depth pavement reconstruction involved less than 20 task orders. Long-term lane closures normally last no more than a week. All lane closures minimally affect the motoring public, causing no congestion delay.

Little warranty work has been performed by NMDOT maintenance personnel. Emergency work was performed by maintenance personnel in 2004 involving an embankment failure, culvert sedimentation, slope erosion, and pavement patching. This work was performed by the NMDOT before having the price agreements in place. The contractor reimbursed NMDOT for costs associated with this work.

The contractor has been responsive in addressing the pavement and structures portions of the project that failed to meet the minimum acceptable performance criteria. In addition, the contractor has been reimbursing NMDOT for funds paid to the contractor under the price agreements for warranty work (Lowry 2007).

State Experience with Warranties

A comprehensive review of state DOT experience of all types of warranty contracting resulted in the findings listed here. Some of the warranty contracts are clearly performance-based; for example, a Wisconsin DOT project included warranty provisions based on a performance distress index and the International Roughness Index (Bayraktar et al. 2004).

- Maintenance warranty projects have included micro-surfacing, chip seals, saw and seal, pavement marking, crack seals, and higher types of asphalt and concrete pavement surfacing, which fundamentally may be rehabilitation and reconstruction projects.
- Bid price is a function of the warranty period. Bid prices for warranty projects are roughly the same as for nonwarranty projects for 1-year periods and increase to about 3% for 3-year warranty periods. Bid prices for 5-year warranty periods for asphalt projects were 9% higher than nonwarranty projects in Ohio.
- The life-cycle costs of 23 asphalt pavement projects were 12% lower for expired warranty projects compared with normal contracted projects.
- North Carolina stopped using warranty provisions for an epoxy-pavement marking project because of an early failure. Montana also experienced failures on pavement marking projects with 4-year warranties.
- The number of bidders remained essentially the same on warranty and nonwarranty maintenance and higher-type projects.
- Eighty-eight percent of state DOTs reported that maintenance cost savings were positive but under 10%, although West Virginia anticipated more than 50% savings on a pavement marking project.
- Roughly 46% of state transportation agencies said there was a slight improvement in project quality, 23% reported there was great improvement, and 31% said the effect of the warranty provisions on quality was unclear.
- Roughly 54% of DOTs asserted that warranty contracting is superior to conventional contracting to obtain better quality and reduce life-cycle costs.

PERFORMANCE-BASED CONTRACTING IN THE FEDERAL GOVERNMENT

Performance-based contracting in the federal government dates back more than 25 years. In 1980, the Office of Federal Procurement Policy (OFPP) issued a pamphlet entitled, “Guide to Writing and Administering Performance Statements of Work for Service Contracts” (OFPP 1980). Around the same time, American Airlines started using performance-based contracts, known as service-level agreements, and other firms in the private sector, such as IBM, followed suit (Hiles 2002).

The DOD encouraged performance-based contracting during the 1980s. Eventually a consensus among federal agencies emerged regarding the virtues of this approach to contracting. The following federal legislation, regulations, and research contributed to a significant shift toward using performance specifications in federal contracts:

- The Government Performance and Results Act of 1993. Federal agencies were required to prepare a per-

formance plan and track progress toward measurable performance targets.

- Federal Acquisition Streamlining Act of 1994. It was necessary to evaluate the effectiveness of implementing the act’s streamlining provisions.
- The Clinger–Cohen Act (formerly the Federal Acquisition Reform Act/Information Technology Reform Act of 1996). This legislation required new programs to meet at least 90% of cost, schedule, and performance goals.
- *Federal Acquisition Regulation*. Changes to the *Federal Acquisition Regulation* supported performance-based contracting.
- The OFPP pilot on PBMC. This project showed that costs declined 15%, customer satisfaction rose 18%, and financial audits declined 93% for 26 performance-based contracts worth \$585 million and involving 15 federal agencies (OFPP 1998).

Mainly as a result of the success of the OFPP pilot, the Office of Management and Budget set a goal that 20% of all eligible service contracts in excess of \$25,000 consist of performance-based contracts (Office of Management and Budget 1998). The Procurement Executives Council set a goal that, by the year 2005, 50% of eligible contracts be performance-based service contracts.

A large body of literature on performance-based contracting is applicable to federal agencies. One of the most widely used sources is Acquisition Central’s online guide, “Seven Steps to Performance-Based Services Acquisition” (see Acquisition Central 2007). This online guide sets out the following basic steps to performance-based contracting:

1. Establish team;
2. Decide what problem needs solving;
3. Examine private-sector and public-sector solutions;
4. Develop a performance work statement (PWS) or statement of objectives;
5. Decide how to measure and manage performance;
6. Select the right contractor; and
7. Manage performance.

A number of features of performance-based contracting in the federal government are somewhat different than the procedures used in highway maintenance contracting in the states, Canada, and around the world. Some of these features are as follows:

1. A great deal of importance is given to the composition and role of the acquisition team.

2. There is a strong emphasis on market research with the cooperation of potential bidders. This must occur without violating procurement integrity.
3. Federal agencies speak of preparing a PWS. This is an outgrowth of the statement of work and leads to the Performance Requirements Summary, discussed later, which becomes the basis, if not the centerpiece, of a performance-based contract. There are a number of different recommendations regarding the contents of a PWS. The DOD has recommended the following typical sections of a PWS (DOD 2001):

- Introduction
- Scope of work
- Requirements
- Data requirements
- Appendix material

The online guide, “Seven Steps to Performance-Based Services Acquisition,” recommends the following contents of a PWS:

- Introduction
- Background information
- Scope
- Applicable documents
- Performance documents
- Deliverables

4. Those developing performance-based contracts are taught to not only establish performance targets but also Acceptable Quality Levels (AQLs). In theory, AQLs address the statistical variability of a measure, similar in concept to Percent within Limits used in highway QA (Weed 2005). Therefore, not only is it desirable to establish a target level of performance but also a minimum and/or maximum level of performance that reflects the known or predicted variation in the performance measure. As a practical matter, many agencies simply set a minimum AQL that addresses both the desired performance target and the minimum acceptable level of performance. Once the performance measures and standards have been developed (both targets and AQLs), then the acquisition team is urged to prepare a Performance Requirements Summary matrix. The Department of Treasury (Rogin 2002) has prepared an example Performance Requirements Summary with the following six columns (see Table 13, which has been slightly modified for this report; (Rogin 2002)):

- Desired outcomes
- Required service
- Performance standard
- AQL
- Monitoring method
- Incentives and disincentives

Note that the contractor is expected to have its own QC process, whereas the Performance Requirements Summary addresses the QA process through performance standards, the AQLs, and some type of contractor monitoring procedure.

5. Many federal agencies have issued Statements of Objectives (SOO) in lieu of an RFP with a PWS or elements of other traditional approaches for performance-based contracting. The SOO is a brief solicitation that shifts most of the responsibility to the contractors for preparing the scope of work, the PWS, and the contractor evaluation plan. The SOO has other benefits, too. It promotes innovation and maximum latitude to potential contractors to find the best way to meet the procurement objectives. The SOO is predicated on the belief that the private sector often has more knowledge and expertise than the government regarding how to provide the services being sought.

To prepare an SOO, the government writes a brief solicitation (usually two to 10 pages), states the agency’s objectives, and asks each offeror to submit a proposal that describes how it will satisfy the objectives. The SOO calls for a performance-based contract. Prospective bidders and the contracting agency, in the spirit of developing a strong partnership as early as possible, typically will have discussed how to meet the agency’s objectives well in advance of the release of the SOO. The SOO does not become part of the binding terms of the contract. Rather the scope of work, PWS, incentives and penalties, and the evaluation plan of the successful bidder are incorporated into the contract (Acquisition Central 2005).

BASIC STEPS OF PERFORMANCE-BASED MAINTENANCE CONTRACTING INFERRED FROM THE FEDERAL LITERATURE

This section draws from an extensive federal literature to elaborate on the basic steps of PBMC. This literature includes a large number of guidance documents from federal agencies and a widely used online resource concerning performance-based service acquisition. Based on federal resources, the steps of PBMC can be described in many ways (Figure 7 illustrates one such way).

TABLE 13
SAMPLE PERFORMANCE REQUIREMENTS SUMMARY MATRIX

Desired Outcomes (what do we want to accomplish as the end result of this contract?)	Required Service (what task must be accomplished to give us the desired result?)	Performance Standard (what should the standards be for completeness reliability accuracy, timeliness quality, and/or cost?)	Acceptable Quality Level (how much error will we accept?)	Monitoring Method (how will we determine that success has been achieved?)	Incentives/Disincentives for Meeting or Not Meeting Performance Standard (what carrot or stick will best reward good performance or punish poor performance?)
Customers calling the help desk shall be able to contact a support staff member from 8:00 AM to 5:00 PM, M–F.	The help desk shall be adequately staffed, with a sufficient number of incoming lines to handle potential trouble calls.	99% of calls are answered on the customer’s first attempt.	99% of calls are answered on the customer’s first attempt.	Survey customers and evaluate feedback. Inspect call logs (trend analysis).	±0.5 of total monthly price
Calls are answered promptly by help desk personnel.	The help desk shall be adequately staffed, with a sufficient number of incoming lines to handle potential trouble calls.	Calls are answered within 20 seconds or a voice mail can be left; calls shall be returned within one hour of receipt.	Calls are answered within 30 seconds or a voice mail can be left; call shall be returned within 2 hours for all classes of customers.	Random sampling of call activity logs, showing time of receipt of call and call return time. Random surveillance of actual operations (trend analysis).	±0.5 of total monthly price
Time to resolve customer problem or answer question is as short as possible; the need to dispatch personnel is minimized.	Time to resolve problem/answer questions is within the time frames set forth in the SOW or in the Service Level Agreement (SLA).	96% of calls received are resolved within one business day.	96% of calls received are resolved within one business day.	Random sampling of call activity logs, showing time of receipt of call and closeout of trouble ticket (Trend analysis).	±0.5 of total monthly price
Help desk personnel are courteous and efficient.	Personnel answering telephones shall be courteous and shall accurately and efficiently log in all incoming calls.	No more than two complaints are made per month regarding courtesy and/or lost/late messages.	No more than two complaints are made per month regarding courtesy and/or lost/late messages.	Sample/test calls will be made to the help desk; customer surveys; complaints will be investigated and resolved within 1 week of filing.	±0.5 of total monthly price

Step 1. Form and Train an Acquisition Team

The literature on PBMC varies considerably regarding the degree that the acquisition team is given attention. It is hardly mentioned in conjunction with the highway maintenance case studies in the literature. *The Guide to Performance-Based Operations Contracting* (Hyman 2003), which covers certain types of maintenance such as snow and ice control operations, devotes considerable attention to the composition and role of the acquisition team. This guide emphasizes that the acquisition team needs to be a

tightly integrated working group that draws on different disciplines. Its size and composition would depend on the complexity and scale of the contract. For small, straightforward contracts, it is usually sufficient for the team to be composed of one or two knowledgeable technical people, including the contract manager and an experienced contract officer familiar with performance-based contracting. If staff are not knowledgeable about PBMC, it is imperative that the all members of the acquisition team educate themselves or receive training regarding performance-based contracting.

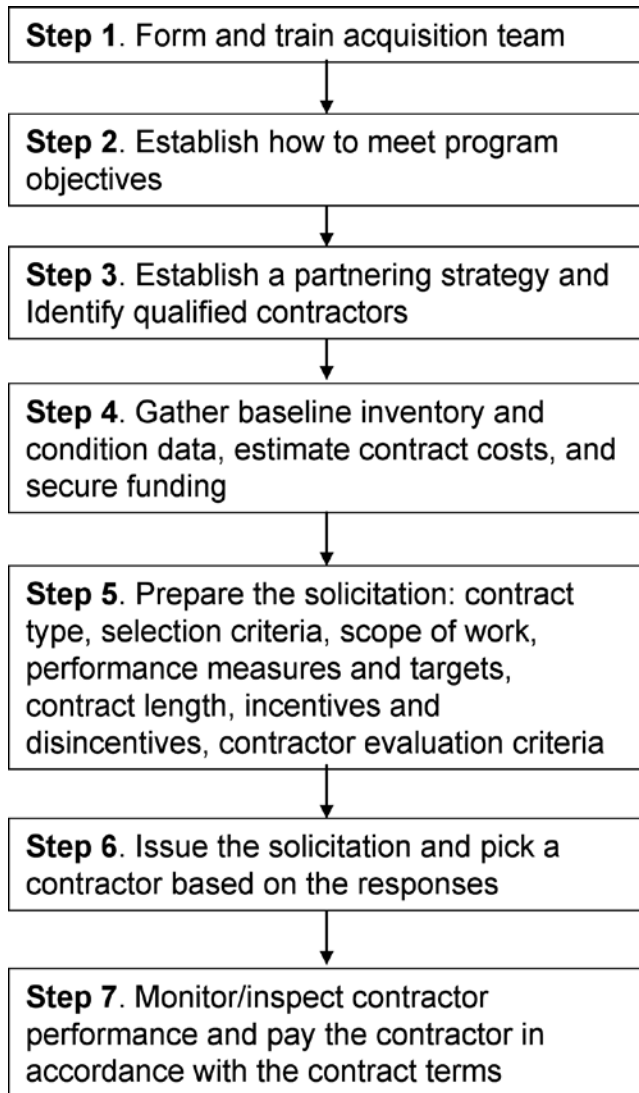


FIGURE 7 Steps for performance-based maintenance contracting.

The guide suggests that for large, highly complex projects the acquisition team could include most or all of the following types of people:

- Program manager
- Project manager
- Technical specialist for each important discipline
- Contracting officer
- Market analyst
- Cost/price analyst
- Small and disadvantaged business utilization specialist
- Finance/budget officer
- Attorney (needed to establish that the agency has statutory authority for PBMC and to review draft and final procurement documents)
- Other stakeholders such as a sponsoring firm, a lending company, a public safety agency (Hyman 2003).

The online guide, “Seven Steps to Performance-Based Service Acquisition,” says teamwork is crucial and that the acquisition team needs to establish ground rules for working together. Drawing on staff with experience in the acquisition process and providing training will help the team to work effectively. The team is likely to go through the well-known steps of becoming acquainted, confronting conflicts and different points of view, developing procedures or rules for working together, getting the job done, and breaking up.

The job of the acquisition team is to ensure that the procurement meets the program objectives and that any contract the agency enters into is successful. Success will be determined by the cost and the degree that performance standards are achieved. More specifically, during its existence, the acquisition team will need to devote significant time and effort to the following, among other things (DOD 2000; Department of Energy 2000; Hyman 2003; Acquisition Central 2005):

- Identify specific objectives associated with the problem or each issue
- Determine the customers/users that will be served
- Establish the desired outcomes and outputs
- Prepare a performance-based work statement
- Establish performance measures
- Establish the performance standards for each measure; include response times as appropriate
- Establish AQLs
- Identify factors outside the control of the agency and contractor and determine the likelihood that those factors will interfere with the contractor achieving the performance targets
- Decide how to best allocate different types of risk among the agency and the contractor.

Step 2. Establish How to Meet Program Objectives

The literature emphasizes a number of important points concerning how to achieve program objectives. The thoughts here amplify themes in the federal literature on performance-based contracting that address issues and practices that highway maintenance organizations normally deal with.

First, it is important to define the program objectives. Program objectives may stem from mandates of the executive or legislative branch to increase the outsourcing of maintenance, increase the amount of work the private sector performs, foster innovation, reduce the size of government, or improve the efficiency and effectiveness of maintenance.

Program objectives may be spelled out in policy, regulations, plans, programs, and other written documents.

Regardless of how and where the program objectives are expressed, it is necessary to clearly understand how

performance-based contracting will serve the customers of the agency—that is, the road users, people who pay for the roads, and owners of land adjacent to the rights-of-way. Typical customer-oriented program objectives include improving accessibility and mobility, preserving investment, reducing accidents, reducing energy consumption, and improving the environment. More narrow objectives might focus mainly on reducing road user costs (accident, travel time, and vehicle operating costs), life-cycle costs, and adverse environmental side effects (Booz Allen Hamilton 2002).

A corollary to defining the program objectives is deciding what to contract. For example, the agency may wish to contract only maintenance of signs, striping, and markers, which has important implications for the safety of road users. An agency could contract for snow and ice control or various bundles of maintenance activities. Another option is to contract for all types of maintenance within the right-of-way of limited-access highways.

Another set of objectives concerns dealing with agency staff in a responsible and sensitive manner and ensuring adequate contractor capacity. Open communication and negotiation with labor unions is part of the answer. As in the case of Finnra, TransitNZ, and other maintenance organizations, it is possible to largely privatize a transportation agency and create something like the FRE, which competes with traditional contractors. The privatization process needs to be handled delicately; otherwise, government employees will not embrace the change and significant damage can occur to the contracting industry (Pakkala 2002).

An issue related to the objective of ensuring adequate contractor capacity is the feasibility of using microcontractors. This was first tried in South America and has become a common practice (Zietlow 2005). In the United States, major maintenance contractors make good use of small contractors to perform various maintenance activities. For example, in Virginia, the interstate maintenance contractor defined three levels of work and engaged corresponding types and sizes of subcontractors (Lande and Dennis 1999).

The agency needs to ask what type of contract is best able to achieve the objectives. The literature suggests the following issues need to be resolved:

- Will a lump-sum contract be used that includes disincentives for failing to meet performance objectives; will there be both disincentives and incentives?
- Will the contract be a hybrid and include lump-sum and unit prices?
- Will the contract be a hybrid in other respects and include outcomes and outputs, maintenance and rehabilitation, performance and method specifications?
- Will the contract be a multiphase contract such as design-build-finance-operate and maintenance?
- What should the term of the contract be? Should it be long enough that the contractor can internalize and minimize life-cycle costs as well as amortize equipment and facilities?
- What will be the contractor selection criteria? Best value, low bid? Part low bid and part technical? What should be the percent weighting of cost versus technical? (Department of Energy 2000; DOD 2000, Pakkala 2002; Stankevich et al. 2006).

Finally, what other institutional and technical issues need to be addressed to achieve the contract objectives? An agency may need statutory authority to undertake PBMC. An agency may need legal authority to consider unsolicited proposals for public-private partnerships—for example, for PBMCs that private firms offer or for design-build projects that extend into the operations and maintenance phases.

Step 3. Establish a Partnering Strategy and Identify Qualified Contractors

The literature on PBMC is virtually unanimous about the importance of partnering between the agency and the contractors. It is critical to eliminate an adversarial relationship so that both parties can focus on the program objectives and achievement of performance standards. The literature is virtually unanimous regarding the need to identify qualified contractors early in the process. A qualified contractor is much more likely to be viewed as a trusted partner. TxDOT found that the professionalism of potential bidders was a key factor in developing acceptance within the agency concerning total maintenance contracts on the busiest portions of TxDOT's Interstate system. Experience and training of the agency and the contractor staff both play an important role in fostering an effective partnership (see citations in Acquisition Central 2005; see also, Graff 2001; Science Applications International Corporation 2007).

According to the literature, there are many ways to identify and engage qualified contractors, including the following:

- Issue a request for prequalifications or use a postbid qualifications process
- Conduct market research to identify qualified contractors
- Solicit comments from contractors, contractor associations, and other stakeholders
- Hold a prequalification or prebid meeting
- Solicit specific suggestions of what to include in the contract—for example, the duration and size of the contract and the contractor evaluation procedure (Acquisition Central 2005 and references cited therein; Pakkala 2002; Science Applications International Corporation 2007).

Step 4. Gather Baseline Inventory and Condition Data, Estimate Contract Cost, and Secure Funding

Transportation agencies about to embark on a performance-based maintenance contract need to compile an inventory of the assets they want maintained and assess the current LOS being provided for different types of maintenance. Some LOS will use measures of condition for physical assets and other LOS will pertain to measures corresponding to maintenance services or operations. This information needs to be shared with prospective bidders who would be given an opportunity to perform an independent assessment. The public agency and bidders could exchange information on inventory, asset condition, and LOS, so there is a mutual understanding of baseline conditions. The transportation agency will need to prepare an estimate of the cost to perform the work and each organization submitting a proposal will need to do likewise.

The transportation agency will need to secure funding for the performance-based contract. The contract period may be short (1 to 3 years) with one or more renewal periods, or it may be long (7 to 15 years). In either case, the agency would make a firm commitment to satisfy its contract obligations. If the agency has a large enough maintenance program, it may be able to meet the commitment through normal expected maintenance appropriations. However, the agency may need to make a formal budget request of the governor (the premier in Canada) and the legislature.

Step 5. Prepare the Solicitation (including contract type, selection criteria, scope of work, performance measures, performance targets, duration of the contract, incentives and disincentives, and performance evaluation criteria)

Most of the issues related to this step were addressed in chapter two. Here, considerations in establishing performance measures are addressed and there is further discussion concerning incentives and disincentives.

A basic task for the acquisition team is to identify the performance measures that will be used. The DOE guidance on performance-based contracting says that performance measures can be objective or subjective, or contain a combination of both. As contracts move in the direction of becoming more outcome-based, performance measures could be more objective, but completely abandoning subjective measures may not be a good idea. Objective measures are based on metrics and can be validated. Subjective measures are frequently categorical but are hard to measure. Subjective measures often are appropriate when it is likely changes will occur outside the contractor's control. The DOE (2000) identified the following metrics with respect to a baseline used to determine incentives or disincentives:

- Objective—measured score based on a quantitative scale.
- Point specific—below a threshold or baseline expressed as a single measurement (e.g., 601 millirem of radiation exposure at a point in time).
- Range specific—performance is graded based on the contractor falling within different ranges (e.g., from below 300 is unacceptable; 300–500 is minimally acceptable; 501–700 is acceptable; and above 700 exceeds baseline).
- Subjective—uses qualitative categories of performance such as unacceptable (e.g., inadequate management oversight); acceptable (e.g., satisfactory management oversight); superior (management demonstrates exceptional oversight).

A key issue is whether many or relatively few measures will be used. The federal and other literature on performance-based services contracting acknowledges that in some circumstances relatively few performance measures are sufficient and in other circumstances many are required.

In practice, within the highway area, most agencies use at least one measure for every type of physical asset and maintenance service in the contract, such as mowing or snow and ice control. Different measures for each type of pavement distress as well as other pavement characteristics are included in many performance-based contracts.

Similarly, there may be multiple condition measures for bridges that, at the minimum, address the deck, superstructure, and substructure—for example, the National Bridge Inventory System (NBIS) condition ratings. However, for states that input inspection data into a Pontis Bridge Management System database, it is more likely there will be 100 condition ratings for each of the CoRe elements. Some or many of these ratings for specific bridge elements could be included in a maintenance contract (AASHTO 1997).

If response times are coupled with each measure for a typical highway section, the total number of performance measures can double. In some cases, performance measures may number in the range of 150 to 250 in a performance-based maintenance contract. With this many performance measures, the contractor must have a rigorous and effective QC plan, and the public agency must be equally fastidious whether it elects to evaluate the contractor's performance or decides to have a third party monitor the contractor's performance in its behalf.

Table 14 presents examples of some performance measures found in various contracts.

TABLE 14
EXAMPLE PERFORMANCE MEASURES, TARGETS, AND RESPONSE TIMES

Performance Measures	Performance Targets and standards	Response Times
Potholes	No potholes allowed [World Bank (WB), Argentina, Uruguay, Chile]	Within 3 days after their detection (WB)
	No potholes > 3 in. x 4 in. x 1 in. (Virginia, D.C.)	Within 2 days after detection; if safety threat act immediately (Virginia, D.C.)
	<10 potholes with a diameter >100 mm on any continuous 5 km of major roads lane (New Zealand)	Within 4 days (New Zealand)
Patching	Should be square or rectangular, level, similar materials, no cracks wider than 3 mm (WB)	Non-complying patches must be repaired within 3 days after their detection
	Should be even and <0.5 in. higher or lower than surrounding pavement (Virginia, DC)	
Cracks	No cracks >3 mm wide For any 50 m section of the pavement, the cracked area cannot be >10% of the pavement surface (WB)	Cracks more than 3 mm wide must be sealed within 7 days after their detection
	No unsealed crack >¼ in. on 95% interstate (Virginia, DC)	
	All cracks should be sealed (Uruguay, Chile)	
	Cracks should be <30% for all sections and <20% for rehabilitated sections. All cracks should be sealed (Argentina)	
Cleanliness of the pavement surface and shoulders	The road surface must always be clean and free of soil, debris, trash and other objects	<p>Dirt, debris and obstacles must be removed:</p> <ul style="list-style-type: none"> • Within 1 h of detecting the condition if they pose a danger to traffic safety • Within 36 h of detecting the condition if they do not pose any danger to traffic safety
Snow removal	Remove all snow to no more than 1 cm Achieve a measure of skid resistance of <0.3 (Finland)	Respond to snow conditions within 2 h Achieve snow removal and skid resistance targets within prescribed amount of time after it stops snowing
Pavement roughness	IRI < 2.8 m/km (Uruguay)	No tolerance allowed
	IRI < 3.3 m/km (Argentina) IRI < 181 in/mi (Virginia, D.C.)	
Rutting	No ruts >15 mm. Rutting <10 mm should not be present in >5% of road (WB)	Rutting above threshold value must be eliminated within 15 days (WB)
	< 2 mm (Argentina)	
	<10 mm (Uruguay)	
	<10 mm (Chile) <0.5 in. Virginia, D.C.)	
	<5 m in any 100 m lane with rutting depth > 30 mm depth (New Zealand)	12 months (New Zealand)
Raveling	Raveled areas must not exist (WB)	Raveled areas must be sealed within 30 days after their detection
	Raveled area should be <50 ft sq. in 0.1 mile section (Virginia, D.C.)	
	No raveling allowed (Argentina)	

Performance Measures	Performance Targets and standards	Response Times
Bleeding	All bleeding surfaces treated (New Zealand)	2 h (New Zealand)
Loose pavement edges	There shall not be loose pavement edges, or pieces of pavement breaking off at the edges (WB) No >5 m of edge break per km where width of seal loss from nominal sealed shoulder edge exceeds 100 mm (New Zealand)	7 days after the detection of the defect (WB) 1 month where sealed shoulder is >0.5 m wide, 3 months otherwise (New Zealand)
Height of shoulders vs. height of pavement	<15 mm difference in height (WB) <30 mm difference in height (Argentina)	Repairs must be completed within 7 days after the detection of the defect
Paved shoulders	Cracks sealed, without deformations and erosions and free of potholes and erosions (WB) Cracks sealed, free of potholes and vertical alignment with pavement should be <1 cm (Chile, Uruguay)	Repairs must be completed within 7 days after the detection of the defect
Guardrails/Cable Rail	95% of guardrail/barrier free of structural defects per 100 ft section All guardrail posts, offset blocks, panels and connection hardware in good condition and in place Cables taut and properly secured according to standard (D.C.)	Repair within 5 days of detection (not actual requirement)
Trees within right-of-way	Trees within right-of-way must be protected as necessary	None
Right-of-way (outside pavement and shoulders)	Height of vegetation (except trees) must <20 cm on slopes towards the road and <1.0 m otherwise, must not disturb drainage (WB) <15 cm height (Argentina, Uruguay)	Vegetation exceeding the threshold height must be cut back within 7 days after detection

With nearly 50 countries engaged in performance-based contracting, it is a daunting task to tabulate and compare all the performance measures in use. (See Appendix B for links to sample procurement and contract documents that contain performance measures from various transportation agencies.) Other sources of performance measures include the following:

- The World Bank (Stankevich et al. 2006)
- Zietlow's website on performance-based management and maintenance of roads from around the world (Zietlow 2005b)
- Proceedings of the National Workshop on Commonly Recognized Measures for Maintenance (Booz Allen Hamilton 2002)
- The appendix material in the NCHRP *Guide for Customer-Driven Benchmarking of Maintenance Activities* (Hyman 2006)

Measurements frequently involve taking observations over a section of road. The length of the section needs to be established. For example, should the section length be 0.1 mile, 50 ft, or 1 mile?

Sampling plans are an integral part of measurement procedures. The agency needs to determine the desired accuracy and confidence interval associated with sampling. Also, the agency needs to establish whether simple random sampling is sufficient or whether stratified random sampling is needed.

Turning to incentives, some considerations, drawn from federal agencies, may be useful to those developing performance-based contracts for highway maintenance (DOE 2000; DOD 2000):

- The performance required to earn positive incentives should be realistic and achievable.
- Incentives could add more value in terms of improved performance (outcomes) than the incentives cost. A corollary is the contracting agency needs to ask whether it is willing to pay for the contractor to produce LOS in excess of performance standards.
- The contractor is not going to spend more than the incentive is worth. It is important that incentives be consistent with the contract value and the effort that will be required to achieve the desired outcomes.
- A cost incentive could be included when there are performance incentives to achieve outcomes and outputs. Otherwise, the contractor may not give sufficient attention to controlling costs. (Note: a lump-sum contract is a natural way to provide a cost incentive because controlling costs helps a contractor maximize profit.)
- If there will be incentives to control costs, the contractor needs a good cost accounting system.
- When a baseline is a foundation for an incentive, objective performance measures are likely to be more appropriate. This will be the case if incentives are established with respect to cost, outputs, outcomes, or even schedule milestones.

- Achievement of performance targets more important to the success of the contract could receive greater incentives.
- The contracting agency should recognize that the incremental increases in performance reflected in one or more measures may require a disproportionate increase in contractor costs. If costs are likely to increase in this way, the contracting agency could provide the contractor increasingly graduated incentives as performance improves.
- Avoid offering incentives under circumstances when the performance sought is beyond the control of the contractor.
- Incentives need to be carefully tailored to yield the desired effect and avoid unintended consequences.
- The contracting agency may wish to design an incentive structure that is consistent with performance, changing on a continuous scale or in discrete increments. For example, most rehabilitation may occur in the first year of a highway contract, followed by nearly all maintenance in the concluding years. In this case, an incentive structure that reflects the sharp change in the type of highway work would be appropriate.
- Performance along a certain dimension may cease to be important after a period of time, and so it would make sense for any incentive for that performance measure to end. For example, an incentive may pertain to an activity on a critical path. When the end of the path has been reached, further incentive is not needed.
- If some dimensions of performance have incentives and others not, the contractor may neglect performance in those areas that do not have incentives. One way to guard against this type of distorted behavior is to condition payment on the contractor's overall performance—that is, require the contractor to achieve an overall level of performance that subsumes any contract goals without specific incentives.

Step 6. Issue the Solicitation and Pick a Contractor Based on the Response

The transportation agency will have to follow the procedures of its office of procurement and contracts in issuing a solicitation and selecting a contractor.

The acquisition team will receive proposals, pick a contractor based on the selection criteria, and conclude any necessary negotiations. The acquisition team must document the reasons it selected a specific contractor. If one or more entities not selected requests a debriefing, the agency must be prepared to provide it. The winning proposal often will become part of the binding terms of the contract (*Federal Acquisition Regulation* 2007); also see various state contracting regulations).

Step 7. Monitor and Inspect Contractor Performance and Pay the Contractor in Accordance with the Contract Terms

Once a contractor is selected and begins work, it will be necessary to monitor the contractor's performance. Generally speaking, an evaluation process, not an inspection process, is required. Both the agency and contractor need to train their staffs regarding what are effective QA/QC processes for performance-based maintenance contracting. Generally the QA/QC process needs to focus on outcomes. There will be exceptions—for example, hybrid contracts that include both method and performance specifications or those with payments based on both lump-sum and unit prices. By and large, a different mind-set is required to evaluate a contractor doing PBMC in comparison to traditional maintenance outsourcing.

The *Guidebook for Performance-based Services Acquisition* identifies five assessment methods (DOD 2000):

1. Random sampling—Works well for establishing whether the contractor meets a target a certain percent of the time. Random sampling is appropriate for large populations. Samples may be taken at any time. The sample size may be adjusted if the contractor consistently demonstrates good or superior performance.
2. Periodic sampling—Similar to random sampling, but occurs at fixed intervals.
3. Trend analysis—Important for assessing the contractor's performance over time.
4. Customer feedback—There are a variety of methods to obtain customer input regarding the contractor's performance. In the case of maintenance customer surveys and a customer service desk that can be reached by telephone and e-mail are two good ways.
5. Third-party audits—independent audits.

Practice at the state and provincial level frequently reflects these basic assessment methods.

The contractor monitoring process is closely related to the nature of the partnering between the agency and the contractor. The evaluation process should be constructive and help the parties achieve the contract's goals and performance objectives. This does not mean one can dispense with objectivity. The agency and contractor, through effective communication, with a positive attitude, and by maintaining an appropriate distance, can have an objective and mutually acceptable evaluation process. An independent evaluator can ensure objectivity; however, as indicated earlier, many agencies believe they lose control by ceding the evaluation responsibility to another entity.

CHAPTER FOUR

INSIGHTS FROM THE SURVEYS

This chapter provides insights based on the responses received from two sets of surveys that were administered as a part of this project:

- Surveys of state DOTs and Canadian provincial transportation agencies
- Surveys of private sector contractors involved in performance-based contracting.

As mentioned earlier, 61 surveys were administered to state DOTs, the District of Columbia, and Canadian provincial transportation agencies. Forty-two were returned for a response rate of 69%. The response rate was 38 out of 51 (75%) for state DOTs and the District of Columbia and 4 out of 10 (40%) for Canadian provincial transportation agencies. Fourteen surveys were sent out to private contractors, but only four provided meaningful responses (a response rate of 29%).

INVOLVEMENT IN PERFORMANCE-BASED MAINTENANCE CONTRACTING

Of the 42 state and Canadian transportation agencies that responded to the survey, 31 said they had never done PBMC and 11 said they had.

State and provincial transportation agencies were asked whether they use performance-based contracting for different types of maintenance contracts. It is most common for a state or province to be involved in an areawide PBMC covering a subunit of the state or province and involving a single activity or a group of related activities such as rest area maintenance. The second most common are areawide contracts covering more than one activity or a related group of activities within a state or province. The third most frequent are fence-to-fence maintenance contracts covering all, or more realistically speaking, nearly all activities in a corridor (see Table 15).

States and provinces were asked to estimate how many different types of performance-based contracts each currently has. Given that only 11 states and provinces have participated in PBMC, but these 11 have 70 performance-based contracts, it is clear that several, if not most, have more than one type of contract. For example, TxDOT has numerous rest area maintenance contracts and fence-to-fence mainte-

nance contracts along sections of the interstate. Based on the *number* of different types of PBMC throughout the United States and Canada, again the most frequent type of performance-based maintenance contracts in rank order are areawide covering a subunit of the state for one activity or related group of activities, areawide covering more than one activity or related group of activities, and fence-to-fence along a corridor (see Table 16).

TABLE 15
AGENCY INVOLVEMENT IN PBMC

Types of Maintenance Contract	Number of Agencies
Areawide contract covering a subunit of the state and involving a single activity or a related group of activities such as rest area maintenance	6
Areawide contract covering more than one activity or related group of activities within a state	5
Areawide contract covering all of the state and all or most maintenance activities	2
Contract for selected activities in a corridor	1
Contract for fence-to-fence maintenance covering all activities in a corridor	4
Total	18

TABLE 16
BREAKDOWN OF NUMBER OF CONTRACTS FOR ALL STATES AND PROVINCES BY TYPE OF PERFORMANCE-BASED MAINTENANCE CONTRACT

Type of Contract	Number
Areawide performance-based contract covering a subunit of the state or province for one activity or related group of activities	20
Areawide performance-based contract for more than one activity or related group of activities	26
Areawide contract covering all or most activities within a state or province	1
Performance-based contract for selected activities within a corridor	3
Performance-based contract covering all activities in a corridor	20
Total	70

TABLE 17
REASONS FOR NOT DOING PBMC

Reasons	Number (% giving answer out of those not doing PBMC)
We have no experience with PBMC and have found our current contracting methods satisfactory.	15 (48%)
There is resistance or discomfort with PBMC on the part of staff and our maintenance leadership. They believe that in the future not only will the performance of contractors be measured but so will the performance of agency staff.	0 (0%)
Our staff and maintenance leadership believe that PBMC could jeopardize many civil servant jobs.	3 (10%)
We do not have the maintenance management systems and quality assurance procedures in place to make PBMC work.	11 (35%)
There is a general mistrust of the private sector.	1 (3%)
Agency maintenance personnel are unionized and the union strongly believes PBMC is not in their interest.	4 (13%)
Our agency has the resources and the expertise to do most maintenance and therefore we contract out only what is essential and see no need to do PBMC.	16 (52%)
We have tried PBMC in the past and did not find it to be successful.	2 (6%)

TABLE 18
WRITTEN EXPLANATIONS FOR NOT CURRENTLY DOING PBMC

State/Province	Explanation
Arizona	Our procurement office is not in favor of performance-based contracts. We use primarily Invitation for Bids.
Connecticut	Existing state contracting laws would make this method of contracting very difficult.
Missouri	We have been doing performance measures on our internal staff since 2002.
Nebraska	We are considering PBMC for some of our maintenance activities such as rest areas and right-of-way mowing.
New Mexico	We have performed basic striping for our high-end epoxy urethane lines to ensure longevity. We have analyzed the proposals set forth by private contractors in the past and found them to be almost twice what it cost for us to do the same job. We also have a long-term warranty on a 90-mile stretch of road that is failing and causing damage to the department's reputation. (New Mexico DOT provided supplementary written material that has been incorporated as a case study in this report.)
North Carolina	North Carolina is in the process of writing its first performance-based contract. The expected advertisement date is August 1, 2007. We believe these types of contracts are another method of getting maintenance work done and can be used effectively in the right environment.
North Dakota	Agency is staffed to provide effective snow and ice control. Maintenance personnel are used to perform the necessary maintenance whenever snow and ice control is not required.
Tennessee	Performance measures are difficult at best to identify for in-house folks. Identifying performance measures for contracts that are reasonable is even more difficult. We have not felt the benefit was worth the effort.
Washington State	Outsourcing in general is still not proven to be a cost savings. Certainly, maintenance work can be contracted out successfully, but that does not mean it will result in cost savings. If it is to be contracted out, we firmly believe that PBMC is the way it needs to be done.
Wisconsin	Wisconsin has a long-standing history of contracting highway maintenance work with our 72 County Highway Departments—We have no state forces for maintenance field operations. We do not use PBMC with the counties and are satisfied with the job they are doing.
Manitoba	We have tried contracting out maintenance services for most activities within a selected area and found poor contractor performance. As a result, Manitoba is reluctant to move toward more contracting out, other than where it is deemed economical or practical to do so (mowing contracts, gravel production, etc.).
Nova Scotia	Political will to move to this type of contracting is not in place. One attempt to move to PBMC in 1999 resulted in the government changing their minds and backing out after union pressure.

REASONS FOR NOT DOING PERFORMANCE-BASED MAINTENANCE CONTRACTING

Those agencies that reported they had not tried PBMC were asked why they had not. As shown in Table 17, generally, the agencies said they have had no prior experience with PBMC, they have the resources to perform the work with in-house staff, they find their current contracting methods satisfactory, or they contract out only what is essential. A number said they do not have the maintenance management systems and QA procedures in place to support PBMC.

Transportation agencies that have not done PBMC were asked to offer a written explanation. The written responses appear in Table 18.

PLANS, PERFORMANCE MEASURES, AND TARGETS

Respondents were asked whether any plans (long-range, strategic, policy, or business) or programs (maintenance, highway, or the Transportation Improvement Program) call for PBMC. Four respondents reported that their agency has plans or programs that call for PBMC. Twenty-nine respondents said their agency has no such plans or programs.

The survey posed a related question that asked whether the agencies published plans or programs to identify specific performance measures that concern important categories of maintenance. Sixteen answered “yes” and 18 answered “no.”

Respondents were also asked whether any of their published plans or programs establish maintenance performance targets or standards corresponding to the performance measures. Roughly an equal number of respondents have plans or programs that do (16) and do not (17) set performance targets for the maintenance measures.

MOTIVATION FOR PERFORMANCE-BASED CONTRACTING

Transportation agencies that have been involved in PBMC have multiple reasons for doing so. Respondents were asked to rate on a scale from 1 (not relevant) to 5 (highly relevant) each possible reason listed in Table 19 explaining why their agency decided to use performance-based contracting.

A main reason that these departments did use PBMC is that they do not have enough labor to do all the maintenance required. Management regards PBMC as an effective response to downsizing. Another reason cited is that PBMC was a logical extension of these agencies’ normal approach to maintenance contracting.

Many agencies see PBMC as being consistent with “management by results” and continuous quality improvement. Additionally, PBMC is consistent with agencies desiring to become outcome and customer oriented.

A reasonably large percentage of agencies that currently do PBMC recognized that they could use incentives and disincentives to motivate contractors and to achieve measurable maintenance outcomes.

Political pressure to rely more on the private sector has been a factor in turning to PBMC and so has predictability of future expenditures because of lump-sum financial commitments to contractors.

Potential cost savings and the ability to shift risk to the contractors have not been significant considerations for U.S. and Canadian highway agencies in deciding whether to do PBMC. The reported success in other states and countries, however, has been a factor in encouraging some agencies to try PBMC.

MARKET RESEARCH, PARTNERING, AND PROCUREMENT

Laying a sound foundation for PBMC involves market research to identify qualified candidates, determine the cost of maintenance services, set the stage for a partnership between the contractor and the client, and design and conduct the procurement to achieve the goals and objectives of the performance-based contract.

Table 20 presents the respondents’ answers to questions regarding these types of issues. The following findings are based on those answers.

All agencies let potential bidders inspect the facilities to assess the current asset inventory and its condition and estimate the cost of performing the work. Seventy percent of the agencies engaged in PBMC provide bidders with inventory and condition data in advance of the procurement or as a part of the RFP. Twenty percent sometimes do.

More than 70% of those agencies engaged in PBMC responded that they (1) identify potential bidders and their capabilities during the procurement phase, (2) hold one or more preproposal conferences, (3) respond to both oral and written questions, (4) place importance on developing a strong partnership with potential bidders as an essential part of PBMC, and (5) reflect the importance of partnering in all the agency’s procurement announcements and the RFP. Half of the agencies doing PBMC interview industry leaders to obtain their input before drafting a RFP.

TABLE 19
REASONS FOR TRYING PBMC

Question	R = 1 (not relevant)	R = 2	R = 3	R = 4	R = 5 (highly relevant)
Over time the number of staff in our agency has been reduced and we do not have sufficient labor resources to conduct all the maintenance required. Management views PBMC as an effective response to downsizing.	2 (18%)	2 (18%)	1 (9%)	4 (36%)	2 (18%)
There has been political pressure to rely increasingly on the private sector and PBMC because they are driven by profit and other performance measures that affect their bottom line.	2 (18%)	3 (27%)	3 (27%)	1 (9%)	2 (18%)
We decided to try PBMC based on the reported success of this approach in other states and/or countries.	3 (27%)	3 (27%)	4 (36%)	0 (0%)	1 (9%)
Reported cost saving of other states and countries prompted us to do PBMC.	6 (54%)	4 (36%)	1 (9%)	0 (0%)	0 (0%)
We believed we could shift most of the risk of contracting from our agency to the contractor by using PBMC.	2 (18%)	4 (36%)	2 (27%)	0 (0%)	3 (27%)
Our PBMCs use lump-sum contracts that provide predictable financial obligations and promote stable expenditures for contract work.	1 (9%)	0 (0%)	3 (27%)	6 (54%)	1 (9%)
Our agency applies the philosophy of “management by results.” PBMC fits well with this management approach.	2 (18%)	3 (27%)	2 (18%)	3 (27%)	1 (9%)
The management approach of our agency has become outcome and customer-oriented. PBMC is consistent with this approach.	1 (9%)	1 (9%)	4 (36%)	4 (36%)	1 (9%)
Our agency contracts out a lot of maintenance and the use of PBMC is a logical extension of our past contracting practices.	2 (20%)	3 (30%)	0 (0%)	3 (30%)	2 (20%)
Our agency’s commitment to continuous quality improvement was an important reason for adopting PBMC because of its focus on measurable outcomes and outputs of contractors.	2 (20%)	2 (20%)	3 (30%)	3 (30%)	0 (0%)
Management had a conviction that the efficiency and effectiveness of maintenance could be improved if contractors were given incentives (or disincentives) for achieving measurable maintenance outcomes.	2 (18%)	1 (9%)	2 (18%)	4 (36%)	1 (9%)

Only a relatively small number do the following as part of conducting market research, partnering, or developing the procurement:

- Issue Requests for Information to learn more about what PBMC entails from the private sector point of view.
- Issue an RFQ or request for Letter of Interest with a request for supporting qualifications before issuing an RFP or PBC.
- Allow potential contractors to have individual discussions with a PBMC technical program manager in advance of issuing an RFP.
- Seek agreement with bidders that the performance measures to be used are practical to apply and will yield measurements consistent with the project objectives the agency is trying to achieve.

- Seek agreement with bidders that the incentives and disincentives incorporated in the PBMC are reasonable.
- Have prospective bidders review and comment on the draft RFP.

Respondents were asked two questions to clarify in writing how they handle key issues that must be addressed in developing a procurement and contract language.

The first question was “Do you seek agreement with bidders that the performance measures that will be used are practical to apply and will yield measurements consistent with the project objectives the agency is trying to achieve? If not, why not?” Responses are presented in Table 21.

TABLE 20
AGENCY APPROACHES TO MARKET RESEARCH, PARTNERING, AND PROCUREMENT

Question	Yes	No	Sometimes
During the procurement phase for a PBMC, does your agency identify potential bidders and their capabilities?	8 (80%)	1 (10%)	1 (10%)
Do you interview industry leaders to obtain their input before drafting an RFP for a PBMC procurement?	5 (50%)	2 (20%)	3 (30%)
Do you issue Requests for Information to learn more about what a PBMC entails from the private sector point of view?	2 (20%)	6 (60%)	2 (20%)
Do you issue a RFQ or LOI with a request for supporting qualifications before issuing an RFP for a PBMC?	1 (10%)	6 (60%)	3 (30%)
Do you issue an announcement of forthcoming procurements regarding an RFP and allow questions and answers prior to the issuance of an RFP?	5 (50%)	5 (50%)	0 (0%)
Do you hold one or more pre-proposal conferences and respond to both oral and written questions?	9 (90%)	0 (0%)	1 (10%)
Do you allow potential contractors to have individual discussions with a PBMC technical program manager in advance of issuing an RFP?	3 (30%)	5 (50%)	2 (20%)
Do you provide baseline inventory and condition data to potential bidders either in advance of issuing the procurement or as a part of the RFP?	7 (70%)	1 (10%)	2 (20%)
Do you allow potential bidders to inspect the facilities they may be responsible for maintaining to determine the accuracy of the baseline inventory and condition data and estimate the cost of doing different types of maintenance work on the road that will be covered by the PBMC?	10 (100%)	0	0
Do you seek agreement with bidders that the performance measures that will be used are practical to apply and will yield measurements consistent with the project objectives the agency is trying to achieve?	1 (10%)	9 (90%)	0 (0%)
Do you seek agreement with bidders that the incentives and disincentives incorporated in the PBMC are reasonable?	2 (20%)	5 (50%)	3 (30%)
Do you have prospective bidders review and comment on the draft RFP?	1 (10%)	6 (60%)	3 (30%)
Is developing a strong partnership between your agency and the contractor an essential part of your approach to a PBMC and is the importance of partnering reflected in all your procurement announcements and the RFP?	7 (70%)	1 (10%)	2 (20%)

Note: The number of responses to each question sums to only 10, even though 11 agencies said they have done PBMC. One agency did not complete these questions.

The second question was “Do you seek agreement with bidders that the incentives and disincentives incorporated in the performance-based contract are reasonable? If not, why not?” Responses from five agencies appear in Table 22.

MAINTENANCE QUALITY ASSURANCE AND BENCHMARKING

Respondents were asked questions about the degree they used two resources developed under other NCHRP projects: (1) *Web Document 8: Highway Maintenance Quality Assurance* (Smith et al. 1997) and (2) *Guide for Customer-driven Benchmarking of Maintenance Activities* (Hyman 2006). As discussed, the NCHRP Highway Maintenance Quality Assurance project involves random sampling of highway sections and periodically measuring the LOS resulting from

different maintenance activities on those sections. LOS refers to either the condition of an asset or the service level that is achieved—for example, roughness of pavement (an asset) or grass height resulting from mowing (a service). Typically, the LOS for each type of asset and service is scored on a scale of 0 (worst possible) to 100 (best possible) and the results weighted to achieve a composite LOS score, also on a scale of 0 to 100.

NCHRP Project 14-13 resulted in a guide on customer-driven benchmarking for maintenance activities. Benchmarking is defined as using outcome, output, and input measures along with factors outside an agency’s control to identify best performers and their corresponding business processes and work methods, which by definition are best practices. Customer-driven benchmarking focuses on customer-driven outcomes (Hyman 2004).

TABLE 21
SELECTED RESPONSES CONCERNING WHETHER AGENCIES SEEK AGREEMENT WITH BIDDERS REGARDING PERFORMANCE MEASURES TO BE USED

State/Province	Responses
Florida	The department identifies the required performance measures with the bidder based on their technical proposal and bid price accordingly.
Idaho	No. We have goal-oriented reasons and the bidders are the same two firms regardless of the type of contract used.
Maryland	We set the standard, not industry.
Oklahoma	Our agency wants to determine the level of service.
Texas	We expect bidders to identify problems during the specification development stage or pre-bid process.
Utah	We gave contractors minimum standards and did not negotiate adjustments.
Virginia	Only to the extent that the bidders ask questions prior to or at the mandatory pre-bid meeting.
New Brunswick	The RFP submission, in addition to the question-and-answer period, will ensure that the standards are clear and will be met.

TABLE 22
SELECTED RESPONSES CONCERNING WHETHER AGENCIES SEEK AGREEMENT FROM BIDDERS AS TO WHETHER INCENTIVES AND DISINCENTIVES ARE REASONABLE

State/Province	Responses
District of Columbia	The department spent enough time preparing the RFP, tries to take all possible scenarios into consideration, and believes that whatever is incorporated is very reasonable.
Florida	We do not seek bidder approval for each contract; instead, we send out our “standard scope” for industry review. Potential bidders have the opportunity to comment on incentives/disincentives at the time of the industry review.
Idaho	No. Goal-oriented reasons and the bidders are the same two firms regardless of the type of contract used.
Virginia	There are no incentives in the performance-based contracts that we use for maintenance. The contractor already has overhead and profit built into the bid price (lump-sum). The contractor has a real internal financial incentive to perform as efficiently as possible to increase his level of profit. Disincentives or penalties are used in Virginia’s performance-based contracts as a way to ensure contract compliance.
New Brunswick	The RFP submission in addition to the question and answer period will ensure all the contract requirements are understood.

As shown in Table 23, 70% of respondents that have done PBMC use some type of MQA coupled with incentives and disincentives. Benchmarking is not so common. Only 3 of 10 respondents indicated that they benchmark the performance of internal organizational units against contractors.

EXAMPLES OF PERFORMANCE-BASED MAINTENANCE CONTRACTS

Respondents who said they were involved in PBMCs were asked to think of a particular performance-based contract and answer a series of questions about it. The questions addressed the following:

- The name of the PBMC
- The scope of work

- The type of contract
- Contractor selection criteria
- The base term, extensions, and the maximum possible duration
- The maximum contract award for the base period and for the maximum duration
- Key performance measures, measurement procedures, and performance targets
- How the performance targets or standards were set
- Questions on the quality of measurements
- Who monitors the contractors performance
- The incentives and disincentives in the contract
- The main steps of business process used for this contract
- Lessons learned
- Key contractual provisions

TABLE 23
USE OF THE MAINTENANCE QUALITY ASSURANCE PROCESS AND BENCHMARKING

Question	Yes	No
Does your agency use a MQA process to measure outputs and outcomes of in-house maintenance efforts?	4 (40%)	6 (60%)
Does your agency use a MQA process to measure outputs and outcomes of contract maintenance?	6 (60%)	4 (40%)
Does your agency use PBMC consisting of a MQA process coupled with incentives and/or disincentives?	7 (70%)	3 (30%)
Do you use benchmarking to compare the maintenance performance of organizational units in your agency?	5 (50%)	5 (50%)
Do you use benchmarking to compare the maintenance performance of organizational units in your agency with the performance of contractors?	3 (60%)	2 (40%)

Four state agencies provided fairly complete responses, TxDOT, FDOT, Maryland SHA, and the Utah DOT (UDOT). The following sections present their responses to the questions for a specific PBMC.

Texas DOT

Figure 8 provides highlights of some of TxDOT's responses concerning five performance-based rest area contracts that cover the state. In addition to the information presented here, TxDOT noted the following regarding these performance-based contracts:

- The measurement procedures used are quite repeatable.
- TxDOT does not rely on industry measurement protocols. The measurement procedures have a very high statistical accuracy and confidence intervals.
- Agency staff monitor the contractor's performance.
- This performance-based contract uses a combination of positive and negative financial incentives to ensure that the contractor is conforming to contract provisions or exceeding performance targets or standards.
- The incentives and disincentives are based entirely on measurable outcomes and outputs.

Florida DOT

Figure 9 provides highlights regarding the numerous asset management contracts used in Florida. FDOT provided the following additional information in the survey concerning its asset management contracts:

- FDOT uses an MQA process and has followed the generally accepted practice of establishing a desired level of service of 80 for each measure.
- Key maintenance managers from throughout the department recommend to top management what the performance targets should be.

- FDOT on a 1 to 5 scale (1 = does not agree; 5 = fully agrees) gave a rating of 3 with respect to the following assertions: our measurement procedures are repeatable, have a high statistical accuracy and confidence interval, and conform to measurement protocols that are commonly recognized in the industry.
- FDOT depends on three sources to monitor contractor performance: agency staff, the contractor, and an independent third party.
- The performance-based maintenance contracts only have disincentives for failure to comply with specific contractual provisions and failure to meet performance targets or standards.
- The disincentives are based entirely on measurable outcomes and outputs.
- Some performance measures are expressed in units of time, such as response time or the period of time in which work must be done.
- The results of the performance measures affect the contractor's ability to secure future work with the agency.
- FDOT sees the following as strengths of its performance-based contracting process: a defined RFP, a defined scope of service, and defined specifications.

Maryland SHA

Figure 10 highlights Maryland SHA's experience with two rest area performance-based contracts. In responding to the survey, Maryland SHA provided the following additional information:

- Maryland SHA uses an MQA process and has followed the generally accepted practice of establishing a desired level of service of 80 for each measure.
- Key managers from throughout the agency recommend to top managers what the performance targets or standards should be.

TxDOT		
Name and Type of Contract: Total Rest Area Maintenance and Operation		
Scope: Five rest area contracts for approximately 92 rest areas across the state.		
Contractor Selection Criteria: Low Bid		
Length of Contract:		
Base number of years	Extension years	Max. duration
2	6	8
Maximum award amount for base period and with extension(s)		
Max. base award	Max. award base + extensions	
N/A	N/A	
Performance Measures		
Not provided		
Steps of the Business Process to Carry out this PBMC		
Description of Action	Who Does It?	
Obtain agreement from management to develop trial PBC	Maintenance Division Director	
Get volunteer department or district to try PBC	Staff /Management	
Write specification	Staff	
Establish limits and type of work to contract	Staff	
Review specification and approval	Staff /Management	
Get legal review	Counsel	
Obtain management agreement	Staff to Management	
Develop detail plans and specification for letting	Staff	
Advertise project	Staff	
Pre-bid meeting	Staff	
Let and select low bidder	Staff	
Award of contract by Transportation Commission	Commission	
Pre-construction meeting and issue work order	Staff	
Start project	Staff	
Close inspection and evaluation of contract	Staff	
Determine if additional contract should be let	Staff/Management	
If satisfactory start development of new contract	Staff	
Select type work for a new project and revise specifications based on finding in trial project	Staff	
Lessons Learned:		
Clear performance standards must be established and communicated to the contractor.	Substantial incentives and disincentives must be established to ensure compliance with minimum performance standards.	Random, unannounced inspections with no grace periods should control incentive and disincentive payments.

FIGURE 8 Information on TxDOT rest area performance-based maintenance contracts.

- Maryland SHA fully agrees with the following assertions: measurement instruments are calibrated where applicable and are in good working order; where industry measurement protocols exist, the agency relies on them for specific measurements; and the measurement procedures have a relatively high statistical accuracy and confidence interval.
- Agency staff monitors contractor performance and the contractor monitors its own performance and provides periodic reports to the agency.

FLORIDA DOT		
Type of Contract: Asset Management (AM) Contracting		
Scope: Generally, AM contractors are responsible for all maintenance activities within a corridor or a geographic area. Each District will identify contract specific needs, which vary on each contract.		
Contractor Selection Criteria: N/A		
Length of Contract:		
Base number of years	Extension years	Max. duration
5–10 years (usually 7)	5–10 years	5–10 years
Maximum award amount for base period plus extension(s)		
Max. base award	Max. award base + extensions	
N/A	Bid amount	
Performance Measures		
Not provided		
Steps of the Business Process to Carry out this PBMC		
Description of Action	Who Does It?	
Project identified	District(s)	
RFP/scope of service developed	District(s)	
Pre-bid meeting	District(s)	
Technical proposal (TP) bid price submitted	District(s)	
Scoring of TP and bid price opening	District(s)	
Award of contract	District(s)	
Lessons Learned:		
Clear, concise procedures/guidelines/project identification is necessary.	Crossing Districts (work identified in several Districts on the same contract) has caused problems (tracking, performance failures, funding, etc.).	Partnership with Contractor is important.

FIGURE 9 Information on Florida DOT’s asset management contracts.

- There are liquidated damages for failure to perform to standards.

Utah DOT

Figure 11 presents key features of UDOT’s performance-based contract concerning rest area maintenance. Additional information UDOT provided in the survey about this contract is as follows:

- UDOT does not use a traditional MQA process but one modeled after the process developed by Washington State.
- Agency staff monitor the contractor and the contractor monitors its own performance and provides periodic reports to the agency.
- This performance-based contract has disincentives for failure to comply with specific contractual pro-

visions and failure to meet performance targets or standards.

- The contract requires rest area employees to be treated as “regular employees” to encourage rest area attendant retention. The contractor provides benefits, insurance, and vacation. UDOT sees this contractual provision as a strength.
- A shortcoming of the contract is paying the contractor on a set monthly basis, which gives the contractor the incentive not to spend money on repair work.

OTHER SURVEY QUESTIONS

The concluding portion of the survey posed a number of additional questions to states and provinces concerning a variety of important topics:

MARYLAND SHA		
Name and Type of Contract: I-96 N/SB Rest Area Asset Management Contract, Howard Co.		
Scope: The Contractor shall manage and perform all routine maintenance and janitorial services.		
Contractor Selection Criteria: Low Bid		
Length of Contract:		
Base number of years	Extension years	Max. duration
5	0	5
Maximum award amount for base period plus extension(s)		
Max. base award	Max. award base + extensions	
\$5,400,000	\$5,400,000	
Performance Measures		
Measures	Methods	Targets
Restrooms	Scheduled and random inspection	100% score
Buildings	Scheduled and random inspection	100% score
Attendant	Scheduled and random inspection	100% score
Roadway	Scheduled and random inspection	100% score
Grounds	Scheduled and random inspection	100% score
Customer Service	Scheduled and random inspection	100% score
Steps of the Business Process to Carry out this PBMC		
Description of Action	Who Does It?	
Discuss areas that would benefit PBC	SHA	
Determine area and define limits	SHA	
Complete an inventory of assets	SHA	
Assess inventory condition	SHA	
Bring items up to par or define for contractor to do	SHA	
Determine scope of services	SHA	
Define the condition level to be maintained	SHA	
Define qualifications of prime and subcontractors	SHA	
Set term of contract	SHA	
Address record keeping	SHA	
Define owner responsibilities	SHA	
Define contractors insurance requirements	SHA	
Determine bonding requirements	SHA	
Establish method of payment	SHA	
Plan inspections	SHA	
Draft Request for Proposal	SHA	
Establish monthly payment minus any liquidated damages	SHA	
Hold pre-bid meeting	SHA	
Make award	SHA	
Have meeting with contractor before start of work	SHA	
Conduct planned and random inspections	SHA	
Lessons Learned		
Snow removal. We learned that this was a hard concept for the contractor to understand. They did not fully understand the performance item, resulting in sub-par performance by the contractor during the first snow event.	It was a good lesson learned that when our contractor was responsible for all maintenance at the rest area facilities, the quality of service went up considerably.	

FIGURE 10 Information on Maryland SHA performance-based contract for two rest areas.

UTAH DOT		
Type of Contract: Lump-Sum, Fixed Price for Rest Area Maintenance; disincentives for any service not meeting minimum performance standards.		
Scope: Statewide maintenance for rest area buildings and grounds.		
Contractor Selection Criteria: Price, experience, capacity		
Length of Contract:		
Base number of years	Extension years	Max. duration
2	3	5
Maximum award amount for base period plus extension(s)		
Max. base award	Max. award base + extensions	
\$3,300,000	\$10,000,000	
Performance Measures		
Measures	Methods	Targets
Janitorial Services	Sniff air in rest room Look around rest room and in stalls	Fresh smell No litter No graffiti
Operation	Observe rest area open times Observe if attendant is on duty during contract times	Open 24 hr/day 100% attendant coverage
Steps of the Business Process to Carry out this PBMC		
Description of Action	Who Does It?	
Publish RFP	State Purchasing Division	
Receive written questions	State Purchasing Division	
Put out addendum	UDOT Maintenance Division	
Receive proposals	State Purchasing Division	
Interview each company	UDOT Maintenance Division	
Make selection	UDOT Maintenance Division	
Notify contractor of award	State Purchasing Division	
Receive performance bond	UDOT Maintenance Division	
Contract is signed	UDOT Maintenance Division	
Notice to proceed	UDOT Maintenance Division	
Lessons Learned		
Agency needs to be specific on contract requirements and performance standards wherever possible.	Threat of invoking disincentives seems to have little effect on performance outcomes.	Repairs under \$500 are paid after the repairs are completed and documented. Repairs are invoiced monthly.

FIGURE 11 Information on UDOT's performance-based contracts for rest areas.

- Hybrid contracts
- The ability of PBMC to foster innovation
- The allocation of certain types of risk
- The feasibility of incorporating PBMC in multiphase contracts
- Simplification of contract administration
- Cost savings
- QC
- Legal issues.

The responses to these questions appear in Table 24.

LESSONS LEARNED

Respondents were given an opportunity to provide up to three lessons learned regarding their experience with PBMC. Table 25 presents the lessons various agencies offered.

TABLE 24
KEY QUESTIONS CONCERNING PBMC

Questions	Yes	No
Do you include method-based and technical specifications along with your desired performance standards/targets in your PBMC?	6 (60%)	4 (40%)
Have you found that PBMC fosters creativity and innovation on the part of the contractor(s) because they are generally free to achieve the performance targets or standards in any manner they choose?	8 (80%)	2 (20%)
Does your agency try to shift to the contractor most or all the responsibility for repairing damage caused by motor vehicle accidents and recovering repair costs?	9 (82%)	2 (18%)
Does your agency expect the contractor to assume most or all the risks for material quantity fluctuations (e.g., sand and salt)?	7 (70%)	3 (30%)
Does your agency expect the contractor to assume most or all of the risks associated with price increases for high-priced items?	7 (70%)	3 (30%)
Have you found the PBMC has allowed you to more easily internalize different phases of a job under one contract (e.g., build, operate, and maintain)?	4 (44%)	5 (56%)
Has PBMC simplified contract administration?	5 (56%)	4 (45%)
Has PBMC resulted in documented cost saving? What is the average percentage cost savings per contract? <i>Florida Reported 2%–15% and Maryland 10%.</i>	3 (30%)	7 (70%)
Do you require your PBMC contractors to have a quality assurance plan?	9 (90%)	1 (10%)
Did you have to obtain special legal authority to do PBMC?	3 (30%)	7 (70%)
Do you have a legislative provision for public-private partnerships that allows a private entity to propose a performance based maintenance contract on part or the entire state highway network?	4 (40%)	6 (60%)

Note: The responses do not necessarily add to the same amount because some agencies decided not to answer certain questions.

CONTRACTUAL PROVISIONS

States and provinces with experience in PBMC were asked to provide up to three example contractual provisions or suggestions that might be useful to others. Those provisions appear in Table 26.

AGENCY PERCEPTION OF CONTRACTOR AND FEEDBACK WITH REGARD TO SERVICE AND PRICE

Agencies were given the opportunity in the survey to offer suggestions regarding what they might do to better meet contractor needs and in turn achieve better results with PBMC. Specifically, agencies were asked “Have you found any ways in which, by better serving the contractors’ needs, your agency has received better LOS or a reduction in the cost of providing service?” Only three agencies responded. Their answers appear in Table 27.

PRIVATE SECTOR SURVEY

A questionnaire tailored to the private sector was sent to 14 firms and four responded. A copy of the questionnaire appears in Appendix A. Confidentiality of the responses was guaranteed.

To respect the anonymity of the respondents, only a few major points are presented here.

The ultimate value to the owner of a performance-based, at-risk, lump-sum contract is the ability of the contractor to assume reasonable risk transfer from the owner, which ensures that owners have a steady budget number on which they can rely over time.

One firm said that a project should be large enough to sustain the contractor’s overhead. At least 500 lane-miles for a performance-based contract is the minimum necessary to attract enough competition so that the bids and proposals the owner receives reflect a competitive value.

A contractor emphasized that it is important to have measurable performance standards with the desired LOS defined and the maximum response time to address each issue.

Other recommendations include the following: (1) that performance standards be reasonable, (2) that the industry provide input into the ability or required cost to meet owner performance standards, and (3) that performance standards be in line with actual conditions. If performance standards are not aligned, the contractor must construct and develop a cost to close the gap between actual and desired conditions. If the gap is too large, the bids or cost proposals that come in may exceed the agency’s budget. Additionally, agencies could avoid requiring a contract to achieve a 100% maintenance rating score 100% of the time.

TABLE 25
LESSONS LEARNED FROM AGENCIES WITH EXPERIENCE IN PBMC

State/Province	Lesson 1	Lesson 2	Lesson 3
District of Columbia	A contract cannot cover every conceivable issue. Project partners must work together within the spirit of the contract to make the project work.	Regular team meetings help to keep outstanding issues in focus until they are resolved.	Make sure the contract is very clear so that everyone is on the same page.
Florida	Clear, concise procedures/guidelines/project identification are necessary.	Crossing districts (work identified in several districts on the same contract) has caused problems (tracking, performance failures, funding, etc.).	Partnership with contractor is important.
Maryland	Snow removal. We learned that this was a hard concept for the contractor to understand. They did not fully understand the performance item, resulting in sub-par performance by the contractor during the first snow event.	We learned a good lesson when we made our contractor responsible for all maintenance at the rest area facilities; the quality of service went up considerably.	
Texas	Clear performance standards must be established and communicated to the contractor.	Substantial incentives and disincentives must be established to ensure compliance with minimum performance standards.	Random, unannounced inspections with no grace periods should control incentive and disincentive payments.
Utah	Agency needs to be specific on contract requirements and performance standards wherever possible.	The threat of invoking disincentives seems to have little effect on performance outcomes.	Repairs under \$500 are paid after they are completed and documentation is provided. Repairs are invoiced monthly.
Virginia	The interstate performance-based maintenance contract in Virginia was procured under the authority of the Public Private Transportation Act. That contract included all maintenance functions (routine and restorative). The contract had no real measure for long-term performance for pavement and bridge assets so there was no incentive for the contractor to maintain those assets with a long-term perspective. The new contracts are only for routine maintenance, where the contractor performed very well in the first contract.		
Ontario, Canada	Strong communication with the contracting industry.	Contract language needs to be biddable and achievable with risk mitigated.	Allow for a period of comfort with contract language and deliverables.

A contractor said that when a contractual provision calls for pre-bid condition assessments by the agency to be measured against the contract performance targets, it contributes to the likelihood of success. The agency is able to establish a baseline and a possible prebid adjustment of the performance threshold. Second, the assessment provides a gauge and clear example for the contractor's benefit on how the agency will be measuring achievement of the performance targets.

The contractor needs a methodical procedure or management system to audit its compliance with the contract performance standards. It is important, however, that the government agency have its own auditing protocol (perhaps not so extensive) to ensure QA and desired contractor performance.

Strict compliance with the contract is essential, especially if the term is long or very long. Otherwise, a deviation could set a precedent that could become problematic later on.

It is difficult to ask the contractor to overperform—to exceed performance requirements—to obtain a bonus when the contractor has guaranteed a price. In response to a recent UDOT request for contractor input, the agency decided to set aside a sum of money every year on which deductions of liquidated damages are made, if any. At the end of the year, the balance of the set-aside goes to the contractor. This is a nice way to provide incentives, while not requiring overperformance.

TABLE 26
SUGGESTIONS OF RESPONDENTS WITH EXPERIENCE IN PBMC REGARDING CONTRACTUAL PROVISIONS

State/Province	Contractual Provisions 1	Contractual Provisions 2	Contractual Provisions 3
Florida	Defined RFP	Defined scope of service	Defined specifications
Maryland	Recordkeeping—We track all services performed, which enables us to compare the previous services.	Desired conditions—lists all assets and the condition level in which they are to be maintained. Requires contractor to maintain the assets at the level set by SHA. The assets are being maintained at a higher level than before.	
Utah	Contract requires that rest area employees be treated as “regular employees” to achieve rest area attendant retention. Contractor provides benefits, insurance, vacation.	Paying contractor on a set monthly basis for anticipated repairs gave the contractor the incentive to not spend money for repair work.	
Ontario	Comprehensive and clear contract language.	Annual lump-sum contract with risk sharing formula.	

TABLE 27
WAYS TRANSPORTATION AGENCIES CAN BETTER
SERVE CONTRACTOR NEEDS

State/Province	Response
Florida	Identification of risk involved
Maryland	Letting the contract provide/replace mechanical items with more up to date and energy efficient ones
Ontario	Risk sharing

One contractor said that it often is asked to assume hundreds of millions of dollars in risk for a \$5 million to \$10 million contract. Another respondent, echoing this concern, said that natural disasters such as tornadoes and hurricanes can have such a negative effect on the contractor that it is not economically feasible to work in an area prone to such weather events. In the case of hurricanes, the contractor can suffer financially while waiting for reimbursement from the Federal Emergency Management Agency. Costs of using subcontractors also can rise rapidly because of the large demand for their services. DOTs must find a more equitable way to share the risks of extreme natural events.

A contractor indicated it would no longer bid on contracts with only disincentives. Exclusive reliance on disincentives undermines the partnering process and, in turn, the performance-based contract.

The standard term for maintenance contracts is now 1 year or, in some cases, 2 years. The contractor who pointed out this standard believes a 2-year term with multiple 1-year

options requiring mutual acceptance at the end of each contract period is the best approach. This provides for a large nonfinancial incentive for both parties to work at their partnering skills if they want performance-based contracting to work. If either party is not satisfied, neither will be happy with a long-term contract.

Another respondent that has contracts ranging from 5 year to 20 years, including all renewal terms, said the period of performance for large-scale performance-based contracts should be 10 years. At a minimum, the contractor needs at least 5 years to depreciate equipment cost. After the first 5 years, the client is able to benefit from the contractor’s familiarity and efficiencies for the remainder of the contract.

Another contractor provides a somewhat different view and stated that the value of the performance-based contract increases with the term because of the contractor’s ability to better manage risk and infrastructure. This contractor believed that 20 years makes more sense for large-scale performance-based contracts. This respondent said that, in general, the term of a performance-based maintenance contract should be at least 5 years.

Finally, a contractor recommended that the owner or agency separate snow and ice control from the base lump-sum bid. Snow and ice control could be paid separately on the basis of a unit price bid. Indeed, snow and ice can dominate a low bid proposal. The entire contract award can be based on how many events the contractor forecasts will need snow and ice control mobilization. Removing snow and ice as a consideration in the lump-sum payment will help ensure that the agency receives the lowest price, not the firm that assumed the lowest number of mobilizations.

CHAPTER FIVE

CONCLUSIONS AND FUTURE RESEARCH NEEDS

Key conclusions of the study are as follows:

- The use of Performance-Based Maintenance Contracting (PBMC) is accelerating worldwide. By 2005, 35 countries had performance-based maintenance contracts. By early 2006, approximately 15 more were exploring this approach to maintenance or adopting it.
- In the United States and Canada, there are already many examples of PBMC. States, provinces, and other entities that have been leaders include Virginia, Texas, Florida, and the District of Columbia, and British Columbia, Alberta, and Ontario.
- PBMC reflects a long-term trend in changing the focus of upper management and maintenance managers to outcomes, especially those that are customer oriented.
- Evidence suggests that PBMC results in better outcomes at lower cost with less risk and more financial predictability for highway agencies.
- The evidence on whether PBMC results in improved levels of service is not consistent. In some cases, particularly in which asset condition or the quality of service are low or have been allowed to deteriorate a great deal, PBMC has resulted in a sharp increase in levels of service (LOS). Also, many other reported improvements in LOS have resulted from PBMC. However, one state and two Canadian provinces, where a large amount of PBMC occurs, do not separate the outcomes achieved by in-house staff and private contractors, and the LOS of contractors cannot be verified. Sometimes LOS will decline at first before starting to rise. The Texas Department of Transportation observed this pattern on two interstate performance-based maintenance contracts.
- A number of agencies are skeptical about the claims of cost savings, even though studies provide evidence that these cost savings exist. These agencies question—as have a number of internal and external audits regarding specific contracts or programs—whether there is a valid basis for cost comparisons between workforce account work and PBMC by private firms. Issues regarding cost comparisons are complex. For example, it is not easy to develop accurate comparisons that place both direct and indirect costs of public agencies and private firms on an equal footing.
- PBMC, despite the success touted by its advocates, is controversial. There is a risk that a large part of the

maintenance organization of a transportation agency will be privatized. As a result, a large number of public employees might have to seek employment with contractors if they wish to continue doing similar work. In-house maintenance staff become unsettled with the potential loss of worker protection and the possibility of reduced pay or benefits.

- The most frequent approach to payment in PBMC is a lump-sum with deductions for failing to meet performance standards. The literature and responses to the surveys suggest that a more balanced approach including both incentives and disincentives is a better approach and enhances partnering.
- Successful partnering appears to be critical to the success of PBMC.
- PBMC is even more likely to succeed when both risks and rewards are shared between the contracting agency and the contractor.
- Many performance-based maintenance contracts are hybrids and include performance and method specifications, payments based on both lump-sum and unit prices, maintenance and rehabilitation work, and different phases of a facility life-cycle such as design, build, operate, and maintain.
- Training has an essential role to play on the part of the contracting agency, the contractor, and any independent third party responsible for evaluating the performance of the contractor.

The following are suggestions for future research:

- Research could be conducted to explore performance measures and measurement protocols concerning LOS for different types of maintenance assets and operations.
- Research is needed on methodologies for evaluating cost savings of performance-based contracting. This research could include an analysis of administrative savings.
- Further investigation regarding the impacts of PBMC on agency staff and how to mitigate adverse effects is desirable. The impacts will vary depending on the percent of maintenance work contracted out under PBMC, whether maintenance is completely privatized, whether there is public–private competition, the size and nature of the contracting community, and the management and organizational structure used.

- More research is required on how to implement an effective benchmarking process that can be used to compare agency and contractor performance (outcomes and outputs relative to costs with adjustments for uncontrollable factors), identify best performers, and determine the corresponding best practices.
- The maintenance community in the United States and Canada could benefit from a set of model procurement documents and contracts. PBMC is continually evolving and these model documents would need to be updated from time to time.
- Training programs would be useful for PBMC. A variety of audiences and formats could be addressed, including maintenance organizations of transportation agencies, contractors, subcontractors, in-house staff and contractors working together, and contractor–subcontractor interaction.

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ABBREVIATIONS

AQL	acceptable quality levels	PWS	Performance Work Statement
CoRe	Commonly Recognized	QA	quality assurance
CREMA	Contrato de REcuperation y MAntenimiento	QBS	quality-based selection
DBOM	design-build-operate-maintain	QC	quality control
DOE	Department of Energy	RFP	Request for Proposal
DOD	Department of Defense	RFQ	Request for Qualification
DOT	Department of Transportation	RTA	Road and Traffic Authority (New South Wales)
ESAL	equivalent single-axle load	SHA	State Highway Administration (Maryland)
FDOT	Florida Department of Transportation	SOO	Statement of Objectives
Finnra	Finland Road Administration	TMC	Term Maintenance Contractor
FRE	Finnish Road Enterprise	Transit NZ	Transit New Zealand
HDM	Highway Design and Maintenance [Standards Model]	TxDOT	Texas Department of Transportation
JLARC	Joint Legislative Audit Review Commission	UDOT	Utah Department of Transportation
JOC	Job Order Contracting		
LOI	Letter of Interest		
LOS	levels of service		
MAC	Managing Agent Contract		
MCA	Maintenance Contract Area		
MQA	maintenance quality assurance		
MRP	Maintenance Rating Program		
MTO	Ontario Ministry of Transportation		
NHS	National Highway System		
NMDOT	New Mexico Department of Transportation		
OFPP	Office of Federal Procurement Policy		
PBMC	Performance-Based Maintenance Contracting		
PSMC	Performance-Specified Maintenance Contract		

GLOSSARY

Acceptable Quality Levels: These performance standards reflect the statistical variation in target levels of performance measures such as outputs and outcomes. Contracting agencies may establish not only performance targets for each performance measure but also acceptable quality levels.

Acquisition: The process of procuring a contractor to enter into a contract to perform a scope of work.

Agency-to-Agency Contract: A transportation agency that has a contract with another city, county, state, or provincial transportation agency to perform road maintenance.

Area Maintenance Contract: A performance-based maintenance contract that focuses on a subarea of a country, state, or province. A Canadian province, for example, might divide the province into numerous areas and enter into performance-based maintenance contracts for each one.

Areawide Contract: A performance-based contract that pertains to an area. A garage or area shop might have a performance contract that pertains to its area. An areawide performance-based maintenance contract could concern a district, city, township, county, state, or country. An areawide contract could cover one activity or all types of maintenance activities and assets within the relevant boundary.

Asset Management Contract (now called Asset Maintenance Contract): A term used for a performance-based contract, usually applicable to maintenance but potentially applicable to all phases of an asset's life-cycle.

Award Fee: An incentive fee consisting of an extra payment for meeting or exceeding one or more desired results. For instance, the award fee might be tied to timeliness of performance.

Award Term: An incentive in which the contractor is awarded an additional contract term for achieving certain desired outcomes or levels of performance.

Benchmarking: Loosely speaking, benchmarking uses measurement to compare the performance of organizational units to one another or with respect to some benchmark. A more rigorous definition describes benchmarking as a way to discover best practices for potential adoption by an organization by using measurement to compare the performance of other organizations and identify those that are the best performers. The business processes of best performers are by definition best practices.

Best Value: A criterion for awarding a contract based on a combination of technical considerations, price, and other

factors—for example, participation by disadvantaged business enterprises.

Commonly Recognized Elements (CoRe): These are standard bridge elements and corresponding possible condition states and definitions of alternative actions. The CoRe elements were adopted by AASHTO and are used in many bridge management systems in the United States and other countries.

Commonly Recognized Measures: These are maintenance performance measures that the highway maintenance community recognizes are in common use. The AASHTO Subcommittee on Maintenance began a process of developing commonly recognized measures.

Concession: A type of contract or agreement that grants to a private entity the right to take over a public road, reconstruct and rehabilitate it as necessary, maintain and operate it, and recover the investment and expenses and earn a profit by charging tolls. A concession may involve granting to a private entity the right to design, build, finance, maintain, and operate a highway. Again, the entity would be permitted to recover its investment and expenses and earn a profit by charging tolls.

Condition Data: Information on the condition of each physical asset or a sample of assets on the highway network or subnetwork. Alternatively, condition data may consist of information on the levels of service that have been achieved for maintenance concerning physical assets and for maintenance operations, such as ditch cleaning, mowing, incident management, and snow and ice control.

Contract for Rehabilitation and Maintenance: Refers to a specific performance-based contract used in Argentina known as CREMA (*Contrato de REcuperacion y MANtenimiento*). In this is a type of performance-based maintenance contract, the first phase begins with an emphasis on rehabilitation. The second phase focuses on maintenance.

Contract for Related Activities: A performance-based contract that pertains to a set of activities that are related by virtue of their location, the type of asset they concern, or other factors. A good example is a contract that concerns rest area maintenance.

Conventional Contract: A contract based on unit prices.

Corridor Contract: A performance-based maintenance contract that pertains to a corridor, such as a long section of limited access highway. These contracts are likely to address a major category of maintenance (e.g., routine maintenance) or a large number of activities. Because these contracts frequently concern most every asset and

maintenance activity that is found in the right-of-way, they are sometimes called fence-to-fence maintenance contracts.

Cost Plus: A contract in which the contractor is paid in accordance with the cost it incurs plus a fixed fee (profit).

Disincentives: Contractual provisions that penalize a contractor for failing to achieve performance standards or other criteria, for example, erecting a work zone and closing one or more lanes during rush hour.

Econometrics: The application of statistical techniques—including those developed within the field of economics—to economic issues.

Evaluation Criteria: Factors used to evaluate contractor performance and that serve as a partial or full basis for payment.

Explanatory Variables: These are variables outside the control of contracting agency and contractor that influence outcomes, outputs, and inputs. Examples include weather, terrain, and traffic growth.

Fence-to-Fence Contract: A performance-based maintenance contract that concerns nearly everything in the right-of-way from fence to fence. Usually refers to a corridor contract.

Fixed Price Contract: In this type of contract, the payment for the work to be performed is a fixed amount.

Hybrid Contract: There are a variety of different hybrid contracts. One has a combination of method specifications and performance specifications. Another has a combination of output and outcome performance measures. A third uses a combination of unit prices and a lump-sum payment, where the latter is adjusted based on whether or not the contractor meets performance standards.

Incentives: Contractual provisions that motivate a contractor to achieve performance standards. Incentives can be positive, negative, or both.

Incentives and Disincentives: Contract clauses that have a positive or negative impact on the contractor's earnings and are designed to motivate the contractor to achieve performance standards and contract objectives.

Inputs: The resources used in maintenance, for example, labor, equipment, and materials. Inputs may consist of dollars or other resources, such as facilities and land.

Inventory Data: The number of each type of maintenance asset that will have to be maintained under a performance-based contract. Inventory data also include each area or feature that will require different types of maintenance, for example, acres of grass that require mowing or linear miles that require tree trimming.

Job Order Contracting: This procurement method typically involves awarding a fixed price contract to a contractor to perform maintenance, repairs, and minor construction work. The contracting agency issues job orders to the contractor such that the total dollar value of the job order does not exceed the contract's fixed price. The contractor is normally paid based on unit costs.

Level of Service: A measure of the condition of an asset or the quality of service a contractor achieves regarding a maintenance service (activity or operation) being provided.

Levels of Service (LOS): The condition of assets and quality of service being achieved for each measurable dimension of maintenance performance.

Liquidated Damages: The sum of money specified in the contract to be paid to the contracting agency by the contractor if there is a breach of contract.

Lump-Sum Contract: A contract such that the maximum payment is a lump-sum amount, usually paid out monthly over the contract term. Deductions or additions may occur if there are negative and positive incentives, respectively.

Maintenance Quality Assurance: A process involving scoring the levels of service a contractor achieves for each performance measure on a numerical scale. Data for calculating the performance measures are based on a random sample of road sections. Scores can be aggregated by area, functional class, and categories of maintenance.

Maintenance Rating Program: A maintenance quality assurance process involving scoring the levels of service a contractor achieves on a 0 to 100 scale for a random sample of road sections. Scores can be aggregated by area, functional class, and categories of maintenance. Florida and other states use a Maintenance Rating Program.

Managing Agent Contracting: A type of performance-based maintenance contracting used in the United Kingdom. In one version, the highway agency transfers responsibility for the network to the Managing Agent Contractor. The role of the contractor includes advising the highways agency and serving as the network contractor.

Method Specifications: The required means and methods for performing work. Method specifications describe how the work is to be performed.

Multiphase Contracts: Some contracts involve more than one phase of an asset's life-cycle and may also include financing. Examples include design-build-operate-maintain, design-build-finance-operate-maintain, and finance-build-sale-leaseback-operate-maintain. A concession applies in a multiphase contract when the contractor is responsible for more than one phase.

Outcomes: The results of undertaking a maintenance activity, or more broadly, the set of results that a contractor achieves in carrying out a performance-based contract. Outcomes may consist of the condition of an asset, the level of service for a certain type of maintenance operation, reductions in life-cycle costs, and reductions in such user costs as accidents and travel time.

Outputs: The accomplishments associated with carrying out a maintenance activity. Examples of outputs are number of lane-miles resurfaced per year, number of potholes repaired per day, and number of damaged sign faces replaced per day.

Outsourcing: Synonymous with contracting out.

Partnering: A process in which the contracting agency and the contractor work cooperatively and constructively to ensure that work proceeds smoothly, to anticipate and resolve issues, and to achieve the contract's performance targets and objectives, which both parties embrace.

Percent within Limits: Performance standards used in highway quality assurance and warranty contracts to reflect the statistical variation in performance measures. Percent within limits represents the percentage of a sample falling above a lower specification limit, below an upper specification limit, or in between.

Performance Contract: In the context of road maintenance, another term for a performance-based maintenance contract.

Performance Measures: Measurement scales that are used as the basis for determining contractor performance with respect to maintenance of assets and providing maintenance services.

Performance Specifications: A set of desired and measurable results that describes the outcomes a contractor is required to achieve, not the methods for achieving them.

Performance-Specified Maintenance Contract: A term used in Australia and New Zealand for a performance-based maintenance contract.

Performance Standard: Targets that represent desired results expressed on a measurement scale.

Performance Target: Synonymous with performance standard.

Performance Work Statement: This includes the scope of work and other information useful in formulating a request for proposal for a federal or other performance-based service contract. Other information might include background and deliverables.

Performance-Based Contract: In the context of road maintenance, another term for a performance-based maintenance contract.

Performance-Based Maintenance Contracting: A method of contracting for maintenance work that uses performance specifications and incentives to achieve desired results.

Procurement: The process of soliciting a firm or entity to enter into a contract to perform a scope of work to achieve a set of objectives.

Public-Private Partnership: A formal or informal agreement in which one or more public sector entities and one or more private sector entities pursue shared objectives. Typically, the public and private sector share both costs and rewards. The characteristics of costs and rewards usually differ. For example, the public sector might provide in-kind resources, while the private sector offers investment dollars. The public sector reaps benefits that flow to road users (a better travel experience) and the private sector earns a profit.

Quality Assurance: A set of procedures that the contracting agency adopts to ensure that the contractor achieves the desired results. This typically involves some type of random sampling and monitoring or inspection.

Quality-Based Selection: Loosely speaking, quality-based selection means picking a contractor based primarily on considerations of quality. A form of quality-based selection is Qualifications-Based Selection, which often is legally mandated when design work is involved. Qualifications-Based Selection would be applicable in many states to a design-build-operate-maintain contract. Qualifications-Based Selection involves issuing an announcement for needed services, identifying a short list of qualified respondents, entering into discussions with each firm, ranking the firms based on their qualifications, negotiating with the highest ranked firm, entering into a contract if the negotiations are successful, turning to the bidder with the next-highest ranking if the negotiations are unsuccessful, conducting negotiations, and so on.

Quality Control: A set of procedures the contractor uses to ensure that it achieves the desired results of the contract. Quality control procedures apply to executing the work, monitoring performance, and applying statistical analysis procedures, if warranted.

Regression: A statistical procedure for establishing the relationship between an independent variable and one or more dependent variables. Regression procedures can establish linear and nonlinear relationships. Linear regression reveals the statistical significance of the independent variables and information on the amount of variation explained by the independent variables.

Requirements Summary Matrix: A matrix that federal agencies frequently use to summarize the key elements of performance-based service contract. The requirements summary matrix typically includes desired outcomes,

required service, performance standards, acceptable quality level, and monitoring method.

Results: Results are the same as outcomes.

Retroreflectivity: A physical measure of the reflectivity of signs, striping, and markers.

Risk: Uncertain costs.

Selection Criteria: In a competitive procurement process, the factors used to select an entity with which an agency will enter into a performance-based maintenance contract.

Single Activity Contract: A performance-based maintenance contract that deals with only a single activity, such as sign replacement or striping.

Single Asset Contract: A performance-based contract that pertains to just one type of asset, but it could involve a single maintenance activity or multiple activities. A performance-based contract for bridge maintenance is likely to involve numerous bridge maintenance activities such as joint repair, bearing replacement, and washing and cleaning.

Statement of Objectives: A four- to 10-page procurement document that federal agencies use to acquire a contractor for a performance-based service contract to achieve specific objectives. The bidders, not the procuring agency, have responsibility for defining the details of the scope of work, tasks, performance measures, performance standards, quality control, quality assurance (monitoring) procedures, incentives and disincentives, contract term and renewals, and the method of payment.

Term Maintenance Contractor: One of the organizational models for delivering maintenance under a performance-based contract in Great Britain. The Term Maintenance Contractor carries out maintenance and limited rehabilitation on the highway network under the instructions of a Managing Agent, which is a contractor and intermediary for the highways agency.

Total Maintenance Contract: A performance-based maintenance contract that addresses a large number of maintenance activities in an area or within a corridor (e.g., along a right-of-way).

Unit Price Contract: A contract for which payments are made in accordance with the unit prices bid for each maintenance activity or bid item.

Value for Money: A surrogate for a benefit-cost ratio—the change in levels of service relative to the change in costs of a performance-based maintenance contract.

Warranty-Based Contract: Two definitions may apply. First, this type of contract requires the contractor to warranty the workmanship and materials for one or more maintenance activities. Second, a warranty-based contract may require the contractor to maintain the end product in the condition specified for a certain number of years. Within the warranty period, if the contractor fails to meet the performance standards, then the contractor must fix the problem. Warranties can apply to pavements, rest areas, signs, striping, and so on.

APPENDIX A QUESTIONNAIRES

This appendix contains blank questionnaires that were administered to U.S. states and Canadian provinces, and private contractors that do PBMC.

STATE/PROVINCE QUESTIONNAIRE

NCHRP TOPIC 37-09

PERFORMANCE-BASED CONTRACTING FOR MAINTENANCE

Background and Purpose

State departments of transportation (DOTs) are confronted with a combination of growing needs and resource limitations for maintaining the highway system. This has intensified their interest in contracting for maintenance services. The transportation agencies have developed various performance-based contracting methods, including the means to measure and report on performance. NCHRP has engaged Applied Research Associates, Inc. (ARA) to conduct a synthesis of practice to obtain information on performance-based maintenance contracting.

The synthesis will explore the following topics:

- Performance standards and relevant measures commonly used to address performance-based contract delivery for different types of maintenance activities
- How performance levels are established, measured, and evaluated in maintenance contracting
- Identified best practices in monitoring and reporting performance-based contract maintenance delivery
- Reported costs, benefits, risks, and possible shortcomings of adopting performance-based maintenance contracts
- Basic elements necessary to initiate performance-based maintenance delivery, including contractor acquisition strategy, evaluation criteria for contractor selection, and prequalification process
- Contractual provisions, such as payment methods, including incentives and disincentives
- Examples of successful and failed applications in performance-based maintenance contracting

One of the main sources of information for this synthesis is a survey of state DOTs and key maintenance contractors.

Please complete the survey on the following pages and return it by e-mail to the principal investigator, William Hyman, at bhyman@ara.com.

All the states share in the costs of this research. Your agency's response will maximize the value of the resulting Synthesis report to every transportation department that sponsored this work. Thank you very much.

Part I. Respondent Information

Head of Maintenance

Name:

Title:

Agency:

Address:

City:

State:

Zip:

Phone:

Fax:

E-mail:

Please return the completed questionnaire by April 24, 2006, to:

William Hyman
 Principal Investigator
 Applied Research Associates, Inc.
 7184 Troy Hill Drive, Suite N
 Elkridge, MD 21075

E-mail: bhyman@ara.com
 Phone: 410-540-9949
 Cell: 301-593-7842
 Fax: 410-540-9288

Part II. Involvement in Performance-Based Contracting (PBC) for Maintenance

1. PBC is a contracting method that provides incentives and/or disincentives to the contractor to achieve desired targets for measurable outputs and outcomes. Does your agency use performance-based contracting for any of the following types of maintenance contracts (check all that apply)?
 - a. Areawide contracts covering a subunit of the state and involving a single activity or a related group of activities such as rest area maintenance
 - b. Areawide contracts covering more than one activity or related group of activities within a state
 - c. Areawide contracts covering all of the state and all or most maintenance activities
 - d. For selected activities in a corridor
 - e. For fence-to-fence maintenance covering all activities in a corridor
 - f. No. Our agency has never done PBC.
2. Please estimate how many PBCs of different types your agency currently has?

a. Areawide PBC covering a subunit of the state for one activity or related group of activities	b. Areawide PBC for more than one activity or related group of activities	c. Areawide PBC covering all or most activities within a state	d. PBC for selected activities within a corridor	e. PBC for fence-to-fence maintenance covering all activities in a corridor

3. If you do not do PBC, check each reason that applies. If you do PBC, skip to question 4. (Note: If you do not feel qualified to give a particular reason, leave the box blank.)
 - a. We have no experience with PBC and have found our current contracting methods satisfactory.
 - b. There is resistance or discomfort with PBC on the part of staff and our maintenance leadership. They fear that in the future not only will the performance of contractors be measured but so will the performance of agency staff.
 - c. Our staff and maintenance leadership fears that PBC could jeopardize many civil servant jobs.
 - d. We do not have the maintenance management systems and quality assurance procedures in place to make PBC work.
 - e. There is a general mistrust of the private sector.
 - f. Agency maintenance personnel are unionized and the union strongly believes PBC is not in their interest.

- g. Our agency has the resources and the expertise to do most maintenance and therefore we contract out only what is essential and see no need to do PBC.
- h. We have tried PBC in the past and did not find it to be successful. If you check this box, please explain:
- i. Other. Please explain directly below:
4. Does your agency or maintenance organization have a *published* plan (strategic, policy, business, system, or highway plan) or program (maintenance program, highway program, transportation improvement program) that calls for PBC? Yes No
5. Do any of your agency's published plans or programs identify specific performance measures that relate to important categories of maintenance? Yes No
6. Do any of your agency's published plans or programs establish maintenance performance targets or standards corresponding to the performance measures? Yes No

IF YOUR AGENCY HAS NEVER USED PERFORMANCE-BASED CONTRACTING (YOU ANSWERED "NO" TO QUESTION "1F"), THEN YOU ARE DONE ANSWERING QUESTIONS. PLEASE RETURN THE COMPLETED PORTION OF THIS SURVEY TO BILL HYMAN BY E-MAIL OR MAIL AT THE ADDRESS ABOVE.

Part III. Motivation for Performance-Based Contracting

Rate on a scale from 1 (not relevant) to 5 (highly relevant) each possible reason listed below regarding why your agency decided to use performance-based contracting:

7. Over time the number of staff in our agency has been reduced and we do not have sufficient labor resources to conduct all the maintenance required. Management views PBC as an effective response to downsizing. Rating:
8. There has been political pressure to rely increasingly on the private sector and PBC because they are driven by profit and other performance measures that affect their bottom line. Rating:
9. We decided to try PBC based on the reported success of this approach in other states and/or countries. Rating:
10. Reported cost savings of other states and countries prompted us to try PBC. Rating:
11. We felt we could shift most of the risk of contracting from our agency to the contractor by using PBC. Rating:
12. Our PBCs use lump-sum contracts that provide predictable financial obligations and promote stable expenditures for contract work. Rating:
13. Our agency applies the philosophy of "management by results." PBC fits well with this management approach. Rating:
14. The management approach of our agency has become outcome and customer oriented. PBC is consistent with this approach. Rating:

15. Our agency contracts out a lot of maintenance and the use of PBC is a logical extension of our past contracting practices. Rating
16. Our agency's commitment to continuous quality improvement was an important reason for adopting PBC because of its focus on measurable outcomes and outputs of contractors. Rating:
17. Management had a conviction that the efficiency and effectiveness of maintenance could be improved if contractors were given incentives (or disincentives) to achieve measurable maintenance outcomes. Rating:
18. Other reason for using PBC:

Rating:

Part IV. Market Research, Procurement, and Partnering

19. During the procurement phase for a PBC, does your agency identify potential bidders and their capabilities? Yes No Sometimes
20. Do you interview industry leaders to obtain their input before drafting an RFP for a PBC procurement? Yes No Sometimes
21. Do you issue Requests for Information to learn more about what a PBC entails from the private sector point of view? Yes No Sometimes
22. Do you issue a Request for Qualifications (RFQ) or Letter of Interest (LOI) with a request for supporting qualifications before issuing an RFP for PBC? Yes No Sometimes
23. Do you issue an announcement of forthcoming procurements regarding RFPs and allow questions and answers prior to the issuance of an RFP? Yes No Sometimes
24. Do you hold one or more preproposal conferences and respond to both oral and written questions? (a) Yes No Sometimes. If you have a preproposal conference(s), is it/are they mandatory? (b) Yes No Sometimes
25. Do you allow potential contractors to have individual discussions with a PBC technical program manager in advance of issuing an RFP? Yes No Sometimes
26. Do you provide baseline inventory and condition data to potential bidders either in advance of issuing the procurement or as a part of the RFP? Yes No Sometimes
27. Do you allow potential bidders to inspect the facilities they may be responsible for maintaining to determine the accuracy of the baseline inventory and condition data and estimate the cost of doing different types of maintenance work on the roads that will be covered by the PBC? Yes No Sometimes
28. Do you seek agreement with bidders that the performance measures that will be used are practical to apply and will yield measurements consistent with the project objectives the agency is trying to achieve? Yes No Sometimes

If no, why not?

29. Do you seek agreement with bidders that the incentives and disincentives incorporated in the PBC are reasonable? Yes No Sometimes

If no, why not?

30. Do you have prospective bidders review and comment on the draft RFP? Yes No Sometimes
31. Is developing a strong partnership between your agency and the contractor an essential part of your approach to PBC and is the importance of partnering reflected in all your procurement announcements and the RFP? Yes No Sometimes

Part V. Use of the Maintenance Quality Assurance Process and Benchmarking

A previous study, NCHRP 14-12, *Maintenance Quality Assurance*, defined a performance measurement process that involves taking a random sample of highway sections, and periodically measuring the Levels of Service (LOS) that result from different maintenance activities. LOS refers to either the condition of an asset or the service level that is achieved, for example, roughness of pavement or grass height achieved by mowing. Typically, LOS for each type of asset and service is scored on a scale of 0 (worst possible) to 100 (best possible) and the results weighted to achieve a composite LOS score, also on a scale of 0 to 100.

32. Does your agency use a Maintenance Quality Assurance process to measure outputs and outcomes of in-house maintenance efforts? Yes No
33. Does your agency use a Maintenance Quality Assurance process to measure outputs and outcomes of contract maintenance? Yes No
34. Does your agency use PBC consisting of a Maintenance Quality Assurance process coupled with incentives/disincentives? Yes No

NCHRP Project 14-13 resulted in a guide on customer-driven benchmarking of maintenance activities. Benchmarking is defined as using outcome, output, and input measures along with factors outside the agency's control to identify best performers and their corresponding business processes and work methods. These are best practices. Customer-driven benchmarking focuses on customer-driven outcomes.

35. Do you use benchmarking to compare the maintenance performance of organizational units within your agency? Yes No
36. Do you use benchmarking to compare the maintenance performance of organizational units in your agency with the performance of maintenance contractors? Yes No

Part VI. An Example of a Performance-Based Contract

In this section, you are requested to provide information on a performance-based contract that you think would be of interest and provide valuable lessons to other states.

37. What is the name of the PBC?
38. Please describe the scope of work (activity specific, corridor, areawide, etc), the general nature of the activities involved, and whether incentives and/or disincentives apply to contractual provisions and/or the achievement of targets for measurable outcomes.
39. What was the type of contract?
40. What was the contractor selection criteria?

41. What was the term of the PBC? Number of years for the base period? Total number of years the contract could be extended? Maximum possible duration of the contract including renewals (extensions)?
42. Maximum amount of contract award for the base period? Total possible contract award covering the base period and all extensions?
43. For the example performance-based contract, please list the key measures, give a brief description of the measurement procedure, and identify the desired performance target:

	Measure	Measurement Procedure	Target (& unit of measure)
a.			
b.			
c.			
d.			
e.			
f.			
g.			
h.			
i.			
j.			
k.			
l.			
m.			
n.			
o.			
p.			
q.			
r.			
s.			

44. Please explain how the performance targets or standards were set for the example contract. Check each that applies:
- a. We use a Maintenance Quality Assurance process and have followed the generally accepted practice of establishing a desired Level of Service of 80 for each measure
 - b. Key maintenance managers from throughout the department recommend to top managers what the performance targets or standards should be
 - c. Top management establish what the performance targets or standards should be based primarily on strategic goals, business objectives, and political considerations
 - d. Other:

45. In regards to the example contract, please rate your agreement or disagreement with the following statements on a 1 to 5 scale (1 = do not agree; 5 = fully agree):
- a. The measurement procedures are repeatable: Rating:
 - b. We insist that measurement instruments are calibrated where applicable and they are in good working order.
Rating:
 - c. Where industry measurement protocols exist, we rely on them for specific types of measurements. Rating:
 - d. Our measurement procedures have a relatively high statistical accuracy and confidence intervals. Rating:
 - e. We use measurement procedures that are commonly recognized within the industry even though no formal set of protocols exist. Rating:
 - f. Other:
Rating:
46. For the example contract, which of the following monitors the contractor's performance? Check each that applies:
- a. Agency staff
 - b. Contractor monitors its own performance and provides periodic reports to our agency
 - c. An independent third party
 - d. Other:
47. What incentives and disincentives are included in the performance-based contract? Check each that applies:
- a. This PBC only has disincentives for failure to comply with specific contractual provisions and failure to meet performance targets or standards.
 - b. This PBC uses only incentives—positive financial rewards—for achieving or exceeding performance targets or standards.
 - c. This PBC uses a combination of positive and negative financial incentives to ensure that the contractor is conforming to contract provisions and/or exceeding performance targets or standards.
 - d. The incentives/disincentives are based entirely on measurable outcomes and outputs.
 - e. The incentives/disincentives relate to contractual provisions but not to measurable outcomes and outputs.
 - f. Our performance measures are all expressed in units of time, such as response time or the period of time in which work must be done.
 - g. The results of the performance measures are used to affect the contractor's ability to secure future work with the agency.
 - h. Other:

48. *OPTIONAL.* For the performance-based contract you selected, *please list the main steps of the business process* your agency used to procure a contractor, award a contract, monitor contract performance, and pay a contractor. If you have a flow chart of your performance-based maintenance contracting business process, you can e-mail that instead to Bill Hyman or send it by regular mail to him at the address at the beginning of this questionnaire.

Step	Description of Action (Indicate if Decision Is Involved)	Who Does It?
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		

Part VII. Lessons Learned from PBC

Please list the three most important lessons your agency has learned regarding PBC that might be of interest to other states.

Lesson 1:

Lesson 2:

Lesson 3:

Part VIII. Contractual Provisions

Please describe three contractual provisions in your performance-based contracts that have influenced the success, strengths, shortcomings, or failures of your PBC efforts:

Contract Provision 1: This provision contributed to (check one): Our success Strengths
 Shortcomings Failure

Contract Provision 2: This provision contributed to (check one): Our success Strengths
 Shortcomings Failure

Contract Provision 3: This provision contributed to (check one): Our success Strengths
 Shortcomings Failure

Part IX. Agency Perception of Contractor and Feedback with Regards to Service and Price

49. Have you found any ways in which by better serving the contractors' needs, your agency has received better levels of service or a reduction in the cost of providing service?

Yes No

If the answer is yes, please explain:

Part X. Additional Issues

Please answer "yes" or "no" regarding these additional questions about PBC:

50. Do you include methods-based and technical specifications along with your desired performance standards/targets in your PBC? Yes No
51. Have you found that PBC fosters creativity and innovation on the part of the contractor(s) because they are generally free to achieve the performance targets or standards in any manner they choose? Yes No
52. Does your agency try to shift to the contractor most or all the responsibility for repairing damage caused by motor vehicle accidents and recovering repair costs? Yes No
53. Does your agency expect the contractor to assume most or all the risks for material quantity fluctuations (e.g., sand and salt)? Yes No
54. Does your agency expect the contractor to assume most or all of the risks associated with price increases for high-priced items? Yes No
55. Have you found that PBC has allowed you to more easily internalize different phases of a job under one contract (e.g., build, operate, and maintain)? Yes No
56. Has PBC simplified contract administration? Yes No
57. Has PBC resulted in documented cost savings? Yes No If yes, what is the average percentage cost savings per contract?
58. Do you require your PBC contractors to have a quality assurance plan? Yes No
59. Did you have to obtain special legal authority to do PBC? Yes No
60. Do you have a legislative provision for public-private partnerships that allows a private entity to propose a performance-based maintenance contract on part or all of the state highway network? Yes No

Part XI. Samples of Performance-Based Contracts

When you return the completed survey, please e-mail to Bill Hyman sample Performance-Based Contract(s) that are typical of the different types you have used in your state. If you do not have copies in electronic form, please mail them to Bill Hyman at his address shown at the beginning of this questionnaire.

THANK YOU FOR YOUR HELP AND COOPERATION

Please return the completed questionnaire by April 24, 2006, to William Hyman at bhyman@ara.com

CONTRACTOR QUESTIONNAIRE

NCHRP TOPIC 37-09

PERFORMANCE-BASED CONTRACTING FOR MAINTENANCE

Background and Purpose

State and provincial departments of transportation (DOTs) are confronted with a combination of growing needs and resource limitations for maintaining the highway system. This has intensified their interest in contracting for maintenance services. The transportation agencies have developed various performance-based contracting methods, including the means to measure and report on performance. NCHRP has engaged Applied Research Associates, Inc. (ARA) to conduct a synthesis of practice to obtain information on performance-based maintenance contracting.

The synthesis will explore the following topics:

- Performance standards and relevant measures commonly used to address performance-based contract delivery for different types of maintenance activities
- How performance levels are established, measured, and evaluated in maintenance contracting
- Identified best practices in monitoring and reporting performance-based contract maintenance delivery
- Reported costs, benefits, risks, and possible shortcomings of adopting performance-based maintenance contracts
- Basic elements necessary to initiate performance-based maintenance delivery, including contractor acquisition strategy, evaluation criteria for selection, and prequalification process
- Contractual provisions, such as payment methods, including incentives/disincentives
- Examples of successful and failed applications in performance-based maintenance contracting

A key source of information for this synthesis is a survey of maintenance contractors that have considerable experience in performance-based contracting.

Please complete survey on the following pages and return it by e-mail to the principal investigator, William Hyman, at bhyman@ara.com.

Thank you very much for your time and effort in completing this questionnaire!

NOTE: ALL ANSWERS TO THIS QUESTIONNAIRE WILL BE TREATED AS PROPRIETARY AND WILL BE LUMPED WITH OTHER RESPONSES AND NOT IDENTIFIED WITH A FIRM.

Part I. Respondent Information

Position in Maintenance Contracting Firm

Name:

Title:

Organization:

Address:

City:

State:

Zip:

Phone:

Fax:

E-mail:

Please return the completed questionnaire by April 23, 2006, to:

William Hyman
Principal Investigator
Applied Research Associates, Inc.
7184 Troy Hill Drive, Suite N
Elkridge, MD 21075

E-mail: bhyman@ara.com
Phone: 410-540-9949
Cell: 301-593-7842
Fax: 410-540-9288

Part II. Acquisition Phase and Partnering

In responding to the following questions, please indicate the percent of time each of the following occurs in regards to procurements for performance-based contracts for all maintenance organizations your firm deals with:

1. During the procurement phase for a PBC, what percent of time does the procurement agency identify potential bidders and their capabilities? Percent of time:
2. What percent of time do procurement agencies interview industry leaders in the private sector to obtain their input regarding a forthcoming PBC procurement? Percent of time:
3. What percent of the time do maintenance organizations issue Requests for Information to learn more about what a PBC entails from the private sector point of view? Percent of time:
4. What percent of time do maintenance organizations issue a Request for Qualifications or Letter of Interest with supporting qualifications before issuing an RFP? Percent of time:
5. What percent of time do maintenance organizations issue an announcement of forthcoming procurements regarding RFPs and allow questions and answers prior to the issuance of an RFP? Percent of time:
6. What percent of time do maintenance organizations hold one or more preproposal conferences and respond to both oral and written questions? Percent of time:
7. If most of the time maintenance organizations hold a preproposal conference, are they mandatory? Yes No Sometimes
8. What percent of time do maintenance organizations allow potential contractors to have individual discussions with a PBC technical program manager in advance of an RFP being issued? Percent of time:
9. What percent of time do maintenance organizations provide baseline inventory and condition data to potential bidders either in advance of issuing the procurement or as a part of the RFP? Percent of time:
10. What percent of time do maintenance organizations allow potential bidders to inspect the facilities they may be responsible for maintaining to determine the accuracy of the baseline inventory and condition data and estimate the cost of doing different types of maintenance work on the roads that will be covered by the PBC? Percent of time:
11. What percent of time do maintenance organizations seek agreement with bidders that the performance measures that will be used are practical to apply and will yield measurements consistent with the project objectives the agency is trying to achieve? Percent of time:
12. What percent of the time do maintenance organizations seek agreement with potential bidders that the incentives and penalties incorporated in the PBC are reasonable? Percent of time:

13. What percent of time do maintenance organizations have prospective bidders review and comment on the draft RFP?
Percent of time:
14. What percent of the time do maintenance organizations seek to develop a strong partnership with private contractors and view this partnership as an essential part of the approach to PBC? Percent of time:
15. What percent of the time do maintenance organizations believe they have little need for input from potential bidders during the acquisition process and the preparation of an RFP? Percent of time:

Part III. Business Issues

Provide a rating from 1 (disagree) to 5 (agree) on the following questions:

16. The rewards exceed the risks on most performance-based contracts? Rating:
17. It is hard to live within the cost constraints of lump-sum contracts. Rating:
18. Lump-sum contracts provide the opportunity to earn larger profits than normal. Rating:
19. Too much of the risk is borne by the contractor. Rating:

Comment:

20. Incentives in performance-based contracts are all negative. Rating:

Comment:

21. The prospect of being able to renew a performance-based contract is a major incentive.
Rating:

22. Do you have the means to control the following costs adequately? We realize you may be unwilling to explain your answers, because your reasons are considered proprietary.

- a. Subcontractor costs? Yes No If you are willing, explain:
- b. Administrative costs? Yes No If you are willing, explain :
- c. Equipment costs? Yes No If you are willing, explain:
- d. Material costs? Yes No If you are willing, explain:
- e. Your firm's labor costs? Yes No If you are willing, explain:
- f. Routine maintenance costs? Yes No If you are willing, explain:
- g. Preventive maintenance costs? Yes No If you are willing, explain:
- h. Demand responsive maintenance costs? Yes No If you are willing, explain:

- i. Rehabilitation costs? Yes No If you are willing, explain:
 - j. Life-cycle costs? Yes No If you are willing, explain:
 - k. Traffic control costs? Yes No If you are willing, explain:
 - l. Emergency operations costs? Yes No If you are willing, explain:
 - m. Customer interaction costs? Yes No If you are willing, explain:
 - n. Client interaction costs? Yes No If you are willing, explain:
23. Do you have a maintenance management system? Yes No
24. A performance measurement system? Yes No
25. Do you have insurance or the equivalent to address unusual costs caused by weather?
Yes No
26. Are you typically required to indemnify the public agency against all damage or costs caused by you as a contractor?
Yes No If yes, do you see indemnification as part of the cost of doing business and an acceptable risk? Yes
No
27. How many years is the *shortest* period of performance of your performance-based contracts, including all option renewals that do not require competition? Years
28. How many years is the *average* period of performance of your performance-based contracts, including all option renewals that do not require competition? Years
29. How many years is the *longest* period of performance of your performance-based contracts, including all option renewals that do not require competition? Years
30. How long do you think the period of performance for large-scale performance-based contracts should be? Years
Explain:

Part IV. Use of the Maintenance Quality Assurance Process and Benchmarking

A previous study, NCHRP 14-15, *Maintenance Quality Assurance*, defined a performance measurement process that involves taking a random sample of highway sections, and periodically measuring the Levels of Service that result from different maintenance activities. Levels of Service refers to either the condition of an asset or the service level that is achieved, for example, roughness of pavement or grass height achieved by mowing. Typically, LOS for each type of asset and service is scored on a scale of 0 (worst possible) to 100 (best possible) and the results weighted to achieve a composite LOS score, also on a scale of 0 to 100.

- 31. What percent of the time do maintenance organizations use a Maintenance Quality Assurance process to measure outputs and outcomes of contract maintenance? Percent of time:
- 32. What percent of time do maintenance organizations use PBC consisting of a Maintenance Quality Assurance process coupled with incentives/penalties? Percent of time:

NCHRP Project 14-13 resulted in a guide on customer-driven benchmarking of maintenance activities. Benchmarking is defined as using outcome, output, and input measures along with factors outside the agency's control to identify best performers and their corresponding business processes and work methods. These are best practices. Customer-driven benchmarking focuses on customer-driven outcomes.

33. Do you use benchmarking to compare the maintenance performance of your firm with other private firms? Yes No
34. Do you use benchmarking to compare the performance of your firm with the maintenance performance of state or provincial DOTs? Yes No

Part V. An Example of a Performance-Based Contract

In this section, you are requested to provide information on a performance-based contract that you think would be interesting and provide valuable lessons to states, Canadian provinces, or other contractors. Skip this section if you have no example to provide.

35. What is the name and location of the PBC?
36. Please describe the period of performance, scope of work, the general nature of the activities involved, and whether incentives apply to contractual provisions and/or the achievement of targets for measurable outputs and/or outcomes.
37. Please describe what you consider the best feature(s) of this performance-based contract:
38. Please describe what you consider the worst feature(s) of this performance-based contract:

39. Please list the key measures in the example performance-based contract, give a brief description of the measurement procedure, and identify the desired performance target, including the unit of measure. You can forward a copy of the maintenance contract instead to Bill Hyman by e-mail, bhyman@ara.com, or to the address at the beginning of the questionnaire:

	Measures	Measurement Procedures	Target (and units of measure)
a.			
b.			
c.			
d.			
e.			
f.			
g.			
h.			
i.			
j.			
k.			
l.			
m.			
n.			
o.			

40. Which of the following monitors the contractor’s performance in the example performance-based contract? Check each that applies:

- a. Agency staff
- b. Contractor monitors its own performance and provides periodic reports to the contracting agency
- c. An independent third party
- e. Other:

41. Please rate your agreement or disagreement with the following statements on a scale of 1 to 5 (1 = do not agree; 5 = fully agree) in regards to the example contract:

- a. The measurement procedures are repeatable. Rating:
- b. The measurement instruments are calibrated where applicable and are in good working order. Rating:
- c. We rely on industry measurement protocols for specific types of measurements. Rating:
- d. Our measurement procedures have a relatively high statistical accuracy and confidence intervals. Rating:

e. We use measurement procedures that are commonly recognized within the industry even though no formal set of protocols exist. Rating:

f. Other:

Rating:

42. What incentives and penalties are included in the example performance-based contract? Check each that applies:

- a. This PBC has penalties only for failure to comply with specific contractual provisions and failure to meet performance targets or standards.
- b. This PBC uses only positive financial rewards for achieving or exceeding performance targets or standards.
- c. This PBC uses a combination of positive and negative financial incentives to ensure that the contractor is conforming to contract provisions and/or exceeding performance targets or standards.
- d. The incentives/penalties are based entirely on measurable outcomes and outputs.
- e. The incentives/penalties relate to contractual provisions but not to measurable outcomes and outputs.
- f. All performance measures are expressed in units of time, such as response time or the period of time in which work must be done.
- g. Other:

Part VI. Lessons Learned from PBC

Please list the three most important lessons your firm has learned regarding PBC that might be of interest to states, Canadian provinces, and other contractors.

Lesson 1:

Lesson 2:

Lesson 3:

Part VII. Contractual Provisions

Please describe three contractual provisions in your performance-based contracts that have influenced the success, strengths, shortcomings, or failures of your PBC efforts:

Contract Provision 1: This provision contributed to (check one): Our success Strengths
 Shortcomings Failure. Please describe the provision:

Contract Provision 2: This provision contributed to (check one): Our success Strengths
 Shortcomings Failure. Please describe the provision:

Contract Provision 3: This provision contributed to (check one): Our success Strengths
 Shortcomings Failure. Please describe the provision:

Part VIII. Additional Issues

Please answer “yes” or “no” to the following issues concerning PBC:

43. Do you observe that methods-based and technical specifications are included along with performance specifications and targets in your PBC? Yes No
44. Have you found that PBC fosters creativity and innovation on the part of your firm because your firm is free to achieve the performance targets or standards in any manner it chooses? Yes No
45. Have you found that PBC has allowed your firm to more easily internalize different phases of a job under one contract (e.g., build, operate, and maintain)? Yes No
46. Do you observe that PBC simplifies contract administration for the contracting agency? Yes No
47. Do you observe that PBC has simplified contract administration for your firm? Yes No
48. Has PBC resulted in documented cost savings to your clients? Yes No If yes, what is the average percentage client cost savings per contract? Please return documentation of cost savings by e-mail or mail to Bill Hyman at the points of contact at the beginning of this questionnaire.
49. Have contracting agencies required you to have a quality assurance plan? Yes No
50. Have you ever taken advantage of a legislative provision for public–private partnerships that allows a private entity to propose a performance-based maintenance contract on part or all of a state or provincial highway network? Yes No

Part IX. Samples of Performance-Based Contracts

When you return the completed survey, please enclose sample performance-based contract(s) that are typical of the different types your firm has been engaged in. If you do not have copies in electronic form, please mail them to Bill Hyman at his address shown at the beginning of this questionnaire.

THANK YOU FOR YOUR HELP AND COOPERATION

Please return the completed questionnaire by April 23, 2006, to William Hyman at bhyman@ara.com.

APPENDIX B

SAMPLE PROCUREMENT AND CONTRACT DOCUMENTS

This appendix includes links to sample procurement and contract documents on the Internet. The sources of these documents are the agencies that produced them. However, the World Bank collected these documents on their website for their resource guide on PBMC.

EXAMPLES OF PROCUREMENT DOCUMENTS

Washington, D.C.

Request for Proposal, Volume 1

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/usa/USA_DC_rfq_doc.doc (accessed April 29, 2007)

Bid Forms

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/usa/USA_DC_bidform.doc (accessed April 29, 2007)

World Bank

Procurement of Works and Services for Output and Performance-Based Contracts and Sample Specifications

<http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/OPRC-10-06.doc> (accessed April 29, 2007)

British Columbia

Request for Qualifications

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/canada/Canada_BC_MOT_RFQ.pdf (accessed April 29, 2007)

Amendment to Request for Qualifications

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/canada/Canada_BC_RFQForms.doc (accessed April 29, 2007)

New Zealand

Excerpt from Pilot Performance Specified Maintenance Contract – PMSC 001

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/new%20zealand/TNZ_PSMC_001.doc (accessed April 29, 2007)

Prequalification Procedure Manual for Trial

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/new%20zealand/Transit_NZ_Prequalification_Manual_Iss4_Nov_2005.pdf (accessed April 29, 2007)

Documents for Consultants Tendering on Pure Performance-Based Maintenance Contracts

Request for Tender

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/new%20zealand/Amendment70_PDFFile.pdf (accessed April 29, 2007)

Schedule of Prices and Basis for Payment

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/new%20zealand/Amendment92_PDFFile.pdf (accessed April 29, 2007)

Conditions of Contract

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/new%20zealand/Amendment93_PDFFile.pdf (accessed April 29, 2007)

Specifications

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/new%20zealand/Amendment94_PDFFile.pdf (accessed April 29, 2007)

Appendixes

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/bidding%20docs/new%20zealand/Amendment95_PDFFile.pdf (accessed April 29, 2007)

EXAMPLE CONTRACTS

Argentina

Contract for Rehabilitation and Maintenance (CREMA—In Spanish)

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/Contract%20docs/Argentina/Argentina_Sample_CREMA.pdf (accessed April 29, 2007)

Performance Specifications (CREMA – In Spanish)

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/Contract%20docs/Argentina/Argentina_Especificaciones_tecnicas.pdf (accessed April 29, 2007)

Queensland, Australia—Road Maintenance Performance Contracts (RMPC) for Main Roads

Volume 1. Sole Invitee, 5th Edition

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/Contract%20docs/Australia/AU_Queensland_RMPC_Vol_1Feb2004.pdf (accessed April 29, 2007)

Conditional Agreement – RMPC Sole Invitee

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/Contract%20docs/Australia/AU_Conditional_Agreement_Sole_Invitee_Appx1.doc (accessed April 29, 2007)

Performance Report – RMPC Sole Invitee

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/Contract%20docs/Australia/4_AU_Performance_Report_Sole_Invitee_Appx2.doc (accessed April 29, 2007)

RMPC Open Competition, 1st Edition

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/Contract%20docs/Australia/AU_Queensland_RMPC_Vol2_Jun_2001.pdf (accessed April 29, 2007)

RMPC Volume 3. Guidelines for Undertaking Routine Maintenance, 4th Edition

http://www.worldbank.org/transport/roads/resource-guide/Docs-latest%20edition/Contract%20docs/Australia/AU_Queensland_Vol3_Feb_2004.pdf (accessed April 29, 2007)

OTHER SAMPLE CONTRACTS FOR POTENTIAL POSTING ON TRB WEBSITE

- Virginia Department of Transportation, Turnkey Asset Management Services on I-81, Rt. 460, I-581, and Rt. 220.
- Virginia Department of Transportation, Turnkey Asset Management Services, I-64
- Maryland Performance-Based Rest Area Contract

- Comprehensive Agreement for Virginia Interstate Highway Asset Management Services between Virginia DOT and VMS
- Bangerter Highway SR-154 Maintenance, Utah Department of Transportation
- Selected Florida asset management contracts

APPENDIX C EVIDENCE ON CHANGES IN LEVELS OF SERVICE AND COST SAVINGS

Information in the two tables in the appendix was assembled to determine whether published information on changes in levels of service and published information on changes in costs were consistent. The body of the text includes more up-to-date information not included here.

LEVELS OF SERVICE

Agency or Contract	Reported Change in Levels of Service
VDOT Total Asset Management	Washington Policy Center: Contract met or exceeded the performance targets for nearly 90% of the items evaluated—no information on change in LOS. James Bryant: In 1995, a report card indicated that the contractor received an overall rating of A with 95% confidence on all mainline sections and all sets of ramps. VDOT's grades on control sections were generally B's. Pekka Pakkala: Better level of service—no data. AASHTO: Improved levels of service—no data.
District of Columbia	World Bank: LOS improved as a result of the performance-based maintenance contract. During the first year, maintenance rating scores increased from the high 20s before starting the contract to the low 80s (out of 100). Pekka Pakkala: Better level of service—no data. Reason: LOS ratings rose to the low 80s in the first year from the high 20s before PBMC occurred.
Texas DOT	TxDOT: Levels of service initially declined on I-20 and I-35 and then started to rise (Graff 2007). World Bank: Relative to their precontract condition, the condition rating of [rest area] facilities maintained under performance-based contracts increased 18 points to 91%. AASHTO: Contractor provided higher-quality snow and ice control than the agency previously did (Note: Washington State DOT cited newspaper articles about poor contractor response to icy road conditions in a Texas contract for highway maintenance (Ribreau n.d.). The articles did not acknowledge these were the worst ice storms in years. The contractor deployed its personnel and equipment. However, in numerous instances, equipment became stuck in traffic and could not get to the areas needing treatment (Segal 2004).
British Columbia Ministry of Transportation (MOT)	Pekka Pakkala: Better level of service; quality of network is good or better than before—no data.
Ontario	Pekka Pakkala: Better level of service; quality of network is good or better than before—no data.
Sydney, Australia (1995, 10-year performance-based contract)	World Bank: 13% improvement in condition. Reason: 13% increase in asset quality condition.
New Zealand	World Bank: The general manager of Transit New Zealand said better services were delivered. Unclear whether this statement applies to a hybrid contract (with both performance and method specifications) or to a long-term performance-based maintenance contract. Pekka Pakkala: Pronounced improvement in quality of service; reduction in bumps; improved skid resistance, signs, drainage systems and marker posts—no data.
Argentina	World Bank: The CREMA performance-based contract began with rehabilitation followed by maintenance. The percent of roads in good to fair condition increased from 59% to 94%. The percent in critical to poor condition declined from 41% to 6%. Also roughness measurements deteriorated at a slower rate than predicted by the Highway Design and

Agency or Contract	Reported Change in Levels of Service
	Maintenance (HDM) Standards Model. Reason: For performance-based maintenance contracts on concession toll roads, Argentina experienced higher levels of service and reduced maintenance costs—no supporting data.
Uruguay	World Bank: The first performance-based maintenance pilots in Uruguay resulted in an improvement in road conditions by the two contractors from 1996 to 1998. The first contractor increased roads in very good condition from 0% to 25% and reduced roads in regular condition from 40% to 15%. Roads in good and bad condition remained unchanged at 60% and 0%, respectively. The second contractor increased roads in very good condition from 23% to 37%, in good condition from 13% to 46% and reduced roads in regular condition from 64% to 17%. The percent of roads in bad condition remained unchanged at 0%.

Sources: World Bank refers to Stankevich, Qureshi, and Querioz (2006); Pekka Pakkala refers to Pakkala (2002); AASHTO refers to AASHTO (2002); Washington Policy Center refers to Segal and Montague (2004).

COST SAVINGS

Location and Description of Project	Source	Change in Costs
Florida DOT		
Seven asset management contracts awarded as of June 30, 2004	Office of Inspector General, Florida DOT	Not able to determine whether Asset Management Contracts are cost-effective. Method used does not reflect actual savings and does not comply with cost estimation Procedure No. 375-000-005. Actual cost savings are not reflected even when the procedure cited above is followed, which compares estimated to letting amounts.
I-75 (253 centerline miles)	Reason Public Policy Institute (Segal et al. 2003)	12.2% below estimate in year 1 and ranging up to 22.2% below estimate in year 7. These cost savings appear to apply to a contract with both performance and method specifications.
Lump-sum contract to manage contract awarded in 2001 to operate and maintain 431 centerline miles on the state system in five counties (District 3)	AASHTO 2002	15% to 20% cost savings.
I-4, from Orlando to Lakeland	Reason Public Policy Institute (Segal et al. 2003)	Costs remained constant. These cost savings appear to apply to a contract with both performance and method specifications.
I-95 near Jacksonville	Reason Public Policy Institute (Segal et al. 2003)	Costs decreased 10%. These cost savings appear to apply to a contract with both performance and method specifications.
	AASHTO 2002	Case study provides no information.
Virginia DOT		
251 miles of Interstate	Reason Public Policy Institute (Segal et al. 2003)	\$16 to \$23 million savings based on a Virginia Tech study
	Ribreau 2004	The Joint Legislative Audit Review Commission concluded that the savings claim of \$16 to \$23 million was, on inspection, neither accurate nor verifiable. Furthermore, the narrow scope of the Virginia Tech study might not provide verifiable

Location and Description of Project	Source	Change in Costs
		conclusions on the cost-effectiveness of the approach.
	De La Garza and Vorster 2000	80% of the contractor work was contracted out; based on a comparison of the contractor subcontracts and VDOT bid tabs for 1999 as well as unit price comparisons, the contractor was able to perform the work for 4.1% less than VDOT could have performed similar work. Extending this analysis so it covered the scope of work in the VDOT interstate maintenance contract, Virginia Tech estimated the cost savings to be 6.1%. Estimated total contract savings over the contract period under baseline conditions was \$8 million and accounting for price escalation reached \$18.7 million. Sensitivity analysis based on varying the overhead rate of the contractor relative to VDOT, after escalating costs according to a price index, suggested cost savings ranged from \$6.5 million to \$22 million.
	AASHTO 2002	Contractor guaranteed cost savings of 17%; VDOT estimated the total cost of the 5.5-year contract at \$131 million. Contractor successfully negotiated a renewal for an additional 5 years. Not clear to what the 17% applies, just first term or both, estimated future costs or actual costs before the contract.
	Pakkala 2002	Cost savings—no substantiating information.
	World Bank (Stankevich et al. 2006)	17% cost savings by VDOT. Based on a study performed by the contractor, its cost per mile was \$22,400 compared with \$29,500 for VDOT.
	<i>Highway Maintenance Contracting 2004</i>	VDOT calculates a 25% contractor cost savings relative to the state. On a per mile basis, the contractor cost \$22,400 compared with \$29,500 for VDOT.
	Stivers 2001	Guaranteed cost savings of roughly 17% versus in-house
	Frost 2001	20% cost savings.
	Joint Legislative Audit and Review Commission (JLARC) 2001	The VDOT estimate of \$23 million in cost savings was based mainly on estimates and forecasts of its future costs in comparison to payments it would make to the contractor. JLARC staff reported in 1998 that the savings could not be supported with documentation and the soundness of the analysis could not be verified. JLARC recognized that the Virginia Tech study might shed light on the cost-effectiveness of this contract. However, JLARC concluded that the narrow scope may not provide conclusive findings.
	Lande and Dennis 1999	VDOT estimated cost savings of \$22 million over the 5.5-year contract.
	Washington Policy Center 2004	Three estimates of cost savings cited. The original VDOT estimate of \$23 million was based on the difference of usual cost of

Location and Description of Project	Source	Change in Costs
		maintenance and the proposed contract cost. Virginia Tech estimated savings of between \$16 million and \$23 million, amounting to 12%. The contractor's estimate of savings was \$8,000 per lane mile of maintenance.
	Bryant 2007	No information provided.
Texas DOT		
Four, 2-year rest area performance-based maintenance contracts at \$6 to \$8 million each	Graff 2007	No information available.
	World Bank (Stankevich et al. 2006)	
	<i>Highway Maintenance Contracting 2004</i>	Not stated whether costs went up or down. Contracts cover enhancement of facilities, janitorial services, and ongoing maintenance.
	Pakkala 2002	Cost savings—no substantiating information.
500-mile Waco and 400-mile Dallas hybrid contracts, including performance measures and method specifications	AASHTO 2002	Bids came in below estimate based on average TxDOT costs to perform the work plus 20% for profit
	Stivers 2001	
	Ribreau 2004	No information provided.
Georgia DOT		
Performance-based contract for mowing interstates	AASHTO 2002	Case study provides no information.
District of Columbia Dept. of Public Works		
75 miles of National Highway System, \$69 million, 5-year contract	Reason Public Policy Institute (Segal et al. 2003)	No information provided.
	Pakkala 2002	Cost savings—no substantiating information.
	World Bank (Stankevich et al. 2006)	
	AASHTO 2002	Case study provides no information.
	Robinson et al. 2005	No information.
Aspen, Colorado		
15-year, maintenance warranty contract for rehabilitation and maintenance	Reason Public Policy Institute (Segal et al. 2003)	Unspecified cost savings.
New Mexico DOT		
Former Corridor 44 (now US 550) 20-year design, construction, maintenance warranty project	Reason Public Policy Institute (Segal et al. 2003)	Speculative information.
British Columbia MOT		
10-year lump-sum performance-based contracts covering all types of maintenance for 100% of British Columbia (since 2003)	World Bank (Stankevich et al. 2006)	Reported savings on order of 10%.
	Pakkala 2002	Clients receive some cost savings (unable to provide any figures).

Location and Description of Project	Source	Change in Costs
Whole province	Stenbeck 2007	Included British Columbia in an analysis of change in costs due to performance-based maintenance contracting for a number of Canadian Provinces, parts of others, the State of Washington, and Sweden. Determined that PBMC resulted in an average increase in costs. Paper does not report cost savings of individual jurisdictions. Results are questionable given that the sample size was small, in most cases there was only one observation per jurisdiction, only one variable was statistically significant, and the Internet paper was not well written or peer reviewed.
Alberta		
Two rounds of tenders of hybrid contracts eventually covering 100% of provincial roads in 30 Contract Maintenance Areas (CMAs)	World Bank (Stankevich et al. 2006)	5% savings for first round of tenders; 25%–35% savings for second round of tenders.
	Pakkala 2002	Clients receive some cost savings (unable to provide any figures)
	Bucyk and Lali (2005)	Based on an independent KPMG report, there were cost savings based on tendering in 17 CMAs: a 28% reduction in cost between the new contracts (year 2000) and the old contracts (prior to 2000) which translates to a reduction in unit prices to \$3,705/km from \$5,117/km representing a total annual cost reduction of \$26,419,932.
Whole province	Stenbeck 2007	Included Alberta in an analysis of change in costs due to performance-based maintenance contracting for a number of Canadian Provinces, parts of others, the State of Washington, and Sweden. Determined PBMC resulted in an average increase in costs. Paper does not report cost savings of individual jurisdictions. Results are questionable given that the sample size was small, in most cases there was only one observation per jurisdiction, only one variable was statistically significant, and the Internet paper was not well written or peer reviewed.
Ontario		
Lump-sum, 7- to 9-year Area Maintenance Contracts	World Bank (Stankevich et al. 2006)	No information provided.
	Pakkala 2002	Clients receive some cost savings (unable to provide any figures).
	<i>Highway Maintenance Contracting 2004</i>	12.5% savings at end of first round of 3-year contracts.
Whole province	Stenbeck 2007	Included Ontario in an analysis of change in costs due to performance-based maintenance contracting for a number of Canadian Provinces, parts of others, the State of Washington, and Sweden. Determined PBMC resulted in an average increase in costs. Paper does not report cost savings of individual jurisdictions. Results

Location and Description of Project	Source	Change in Costs
		are questionable given that the sample size was small, in most cases there was only one observation per jurisdiction, only one variable was statistically significant, and the Internet paper was not well written or peer reviewed.
Australia		
Regional Transport Authority, New South Wales; Tasmania; Western Australia	Pakkala 2002	10% to 35%
10-year, \$130 million, 450 km urban road contract	Reason Public Policy Institute (Segal et al. 2003)	35% cost savings through some initial portion of contract.
	World Bank (Stankevich et al. 2006)	20%–30% cost reduction; bid price 25% lower than estimated.
Sydney, New South Wales	Frost 2001	38% cost savings compared with schedule of rates type of contracts.
Southern Tasmania	Frost 2001	20% cost savings compared with schedule of rates type of contracts.
South Perth	Frost 2001	25% cost savings compared with schedule of rates type of contracts.
Mid North Region	Frost 2001	30% cost savings compared with schedule of rates type of contracts.
Six contracts in Western Australia	Frost 2001	Savings of 15%–20% against in-house operations.
New Zealand		
10-year, lump-sum performance-specified maintenance contract for nearly all road and highway works throughout country; includes rehabilitation and maintenance	Reason Public Policy Institute (Segal et al. 2003)	20% savings based on regular audits.
	World Bank (Stankevich et al. 2006)	Reduced cost according to general manager of Transit New Zealand
	<i>Highway Maintenance Contracting 2004</i>	30% decrease in cost of professional services and 17% decrease in costs of professional services; a savings of at least 25% over conventional model.
10-year, lump-sum, performance-specified maintenance contract (PSMC-001) covering 450 km	Pakkala 2002	Initial savings were about 25%, and were between 14% and 20% when the report was written. Savings predicted to be 25%.
Argentina		
9,600 km of national roads under 12-year toll concession and additional 10,000 km under 5-year rehabilitation and maintenance contract	Reason Public Policy Institute (Segal et al. 2003)	Unspecified lower maintenance costs.
	World Bank (Stankevich et al. 2006)	Rehabilitation cost savings were due in part to a difference in pavement thickness under the CREMA versus the prior Provincial Roads Rehabilitation Projects. Savings varied depending on thickness and were actually greater because design and other costs customarily taken into account were excluded

Location and Description of Project	Source	Change in Costs
		under the CREMA cost estimates. The lump-sum contract arrangement during Phase I virtually ensured no overruns except for force majeure events. Annual costs never exceeded the lump-sum amount by more than 3%.
Finland		
	<i>Highway Maintenance Contracting 2004</i>	Cost savings analyzed at 7%–10% for 3-year contracts and 13% for 7-year contracts.
		30%–35%; about 50% less cost per kilometer. the Finnish Road Enterprise became one of numerous state companies under Finnra's umbrella, and won 78% of the 3-year contracts.
	World Bank (Stankevich et al. 2006)	7%–10% for 3-year contracts and 13% for 7-year contracts; the current price level is 50% to 60% of the price level when Finnra was using its own labor and equipment to do maintenance.
	World Bank Transport Note No. TN-27 (Stankevich, Qureshi, and Querioz 2005)	30%–35%; about 50% less cost per kilometer.
United Kingdom		
	<i>Highway Maintenance Contracting 2004</i>	Slightly reduced costs. No supporting data provided.

Abbreviations used without definition in TRB Publications:

AAAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETY-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation