

A Framework for Monitoring Performance-Based Road Maintenance Contracts

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Reducing maintenance costs and providing timely improvement of transportation facilities are the major goals of public transportation agencies for the preservation of the existing infrastructure. Throughout the years, some agencies have not been able to accomplish these goals by using the traditional methods of preservation. As a result of this, such agencies considered privatization as an alternative tool to improve the delivery of public services. One of the most recent initiatives is the implementation of public-private partnerships for preserving public roadways. Most of these initiatives are executed under Performance-Based Road Maintenance Contracts (PBRMC). This contracting scheme is a promising tool to improve government efficiency in maintaining transportation networks; however, without proper monitoring, this type of contract can yield adverse outcomes. This paper presents a framework developed to provide road administrators with a reliable and comprehensive methodology to monitor PBRMC.

Key Words: Performance-based Contracts, Road Maintenance, Performance Measurement

Introduction

According to Giglio and Ankner, privatization is a very useful tool for improving the delivery of public services (Giglio & Ankner, 1998). Ignoring or prohibiting the use of privatization as an alternative to provide services can result in the loss of an opportunity to improve government efficiency. On the other hand, privatizing government services without proper monitoring can yield adverse outcomes (Finley, 1989). Despite the fact that numerous goods and services have been provided to the government by the private sector, many transportation agencies have been reluctant to give private sector the full responsibility of maintaining the transportation infrastructure (Grimsey & Lewis, 2002). In traditional road maintenance contracts, transportation agencies specify how the work is going to be undertaken, the means and methods that are going to be used, and the sequence in which the job is going to be performed. Furthermore, in almost all cases, traditional road maintenance contracts: (i) cover short road sections (e.g., 2-5 miles), (ii) are short-term (e.g., 1 year), and (iii) focus on a few asset items (e.g., pavement and shoulders only or guardrail only). According to some road administrators, traditional contracting approach has failed to meet the goals of reducing maintenance expenditures and improving the services to the traveling public (Porter, 2006).

In the late 1980's this philosophy started to change when a few transportation agencies around the world began considering privatization as an alternative to improve the efficiency of the services provided to public. As a result of this initiative, new partnerships between the agencies and private sectors were implemented for preserving the public roadways. Such partnerships resulted in the development of new contracting schemes, prominent of which are the Performance-Based Road Maintenance Contracts (PBRMC). PBRMC call for performance-based work, in which a desired outcome is specified rather than the materials or methods to be used. In other words, this contracting scheme focuses on the final product and not on how it is achieved. Furthermore, as investigated within the context of this paper, PBRMC: (i) cover long road sections (e.g., an entire county or district of the transportation agency), (ii) are long-term (3-5 years with the option of multiple renewals), and (iii) focus on all of the asset items within the right-of-way fences. In this sense, PBRMC are different from the performance-based specifications that have been utilized for a long time for individual contracts aimed at dealing with a single asset item (grass, striping, etc.).

Since PBRMC are relatively new, the availability of reliable and comprehensive sets of guidelines to evaluate the effectiveness and efficiency of this type of contract is limited. Transportation agencies currently rely on criteria and procedures they have developed for their traditional methods to evaluate the performance of contractors in maintaining the public roadways. These procedures vary significantly among implementing agencies and some of them have not been properly defined to monitor PBRMC. The fact that the use of PBRMC is proliferating among transportation agencies necessitate an immediate revision of the current performance evaluation procedures and the development of comprehensive guidelines that will assure the reliability of the overall performance evaluation. The objective of this paper is to address this need by developing a framework which provides a reliable and comprehensive methodology that transportation agencies can use to monitor PBRMC.

Framework Components

The components of the framework were identified by performing an extensive literature review of (i) existing performance-based road maintenance contracts around the world and (ii) comprehensive documents that describe existing approaches commonly used in the public and private sector for measuring and monitoring performance. Particularly the following six approaches were included in the review: (i) ISO 9001:2000 Criteria for Performance Excellence, (ii) Malcolm Baldrige National Quality Program, (iii) Kaplan and Norton's Balance Scorecard Approach, (iv) Mark Graham Brown's Scorecard Approach, (v) Department of Energy Performance Measurement Program, and (vi) NCHRP 14-12: Highway Maintenance Quality Assurance Program. The review conducted as a part of this study led to the identification of five key components that define the framework to monitor PBRMC. Once the components were identified, the sections in each component and the content for those sections were developed. A brief description of each component follows. The rest of the paper discusses each component in detail.

1. Level of Service Effectiveness indicates the extent to which the performance criteria and performance targets defined in the contract are being met.
2. Timeliness of Response evaluates the response time of the contractor to service requests related to events or deficient elements in the roadway that need to be attended in a timely manner.
3. Safety Procedures evaluates if a safety program is properly implemented by the contractor. This component is very important to ensure that the roadway users as well as the maintenance crews performing the work are exposed to minimum risk of accidents.
4. Quality of Services assesses the customer perceptions with respect to the condition of the assets and contractor performance. Customers are the ultimate evaluators of the quality of the service provided; therefore, it is extremely important to assess their satisfaction.
5. Cost-Efficiency assesses the cost savings, if any, accrued by the government as a result of engaging a contractor to perform performance-based road maintenance services.

Component 1: Level of Service (LOS) Effectiveness

According to Poister, the level of service effectiveness is considered as one of the most important performance indicators to be incorporated into a monitoring system (Poister, 1983). The methodology developed to evaluate the level of service effectiveness in PBRMC consists of four sections and elements within those sections as discussed below.

Section 1: Input for LOS Evaluation

Assets to be maintained. One of the first decisions to be made by the road administrators before implementing PBRMC is to define the road network to be contracted out to the private sector. Departments of transportation (DOTs) implementing this contracting scheme for the first time are advised to select small portions of the networks as pilot projects. In addition to identifying the network to be contracted out, it is strongly recommended to also identify portions of the network that will still be maintained by traditional means and that will be exposed to similar conditions to the roads that are going to be maintained by PBRMC. Identifying these similar portions of the network will allow road administrators to perform a comparison of the level of service at which each party maintains the assets (i.e., the party performing road maintenance under performance-based road maintenance contracting versus the party performing maintenance under traditional contracting).

Inventory and condition of the assets to be maintained. Once the portion of the network to be contracted out is identified, a complete inventory and condition assessment of all assets for which the contractor will be responsible needs to be created. This is extremely important in order to provide the prospective contractors with the inventory and condition information of the assets located within the portions of roads to be included in the performance-based road maintenance contract. This information can be gathered through field inspections, windshield inspections, and/or from existing agency records.

Performance measures (criteria). Since PBRMC are outcome-based contracts, road administrators need to define performance measures (criteria) that specify the standards through which the maintenance work performed by the contractor will be evaluated. Defining the “right” performance criteria is a very challenging task. The main goals when defining these criteria are: (i) to ensure the safety and comfort of the road users and (ii) to ensure that each asset type will be preserved at a minimum acceptable level of service throughout its life. A performance criterion should be easily measurable and quantifiable (e.g. “more than 90% of pipe diameter needs to be open”).

Performance targets. In all performance-based work, there has to be a tolerance or acceptable quality level, better known as performance targets. A separate performance target should be defined for each asset item depending on the importance of each asset item within the roadway system. It is important that transportation agencies define realistic targets for two reasons: (i) the payment to the contractor will be based on the compliance to these targets and (ii) the overall condition of the assets will be affected by the effort made by the contractor in meeting or exceeding the targets. The timetable to reach the performance targets needs to be explicitly defined, particularly at the inception of a performance-based road maintenance contract when the current conditions are well below targets. Road administrators must also define the mechanisms to penalize the contractor for failing to reach the targets. The penalties can be monetary (e.g., reduction in payments) or non-monetary (e.g., reduction in contract duration). Including penalties in PBRMC is in accordance with the philosophy that payments must be made based on the results achieved by the contractor and not simply on the amount of cost incurred or work done.

Relative weight among assets. Given their safety implications, some asset items are more important than others. Therefore, it is suggested to establish two sets of relative weights; one set among the asset items (e.g. pipes, paved ditches, unpaved ditches, etc.) within each asset group (e.g. drainage asset group), and another set for the main asset groups (e.g., pavement, bridges, drainage). The purpose of these weights is to establish relative importance among asset items and asset groups. These weights will be used in the overall calculation of the LOS ratings (Stivers, Smith, Hoerner, & Romine, 1997).

Section 2: Data Collection for LOS Evaluation

Data collection plan. A data collection plan is essential to ensure that the collected data supports the overall objectives of the performance monitoring program. The main objective of the data collection plan is to identify the information needed as well as the sources that can provide that information. Therefore, the first step is to identify the main asset groups that are required to be maintained by the contractor. Once the asset groups (e.g., pavement, bridges, drainage) are identified, the next step is to identify the data sources (e.g., Pavement Management System, Bridge Management System, field inspections) to be used to get the necessary information (TRB, 1997). Attention must be paid to collect only the information that is needed, not all that is available.

Sample selection process. When collecting data for the whole population is not feasible, sampling is considered as a useful way to maximize the benefits of the data collection effort. Sampling refers to the measurement of only a portion of the whole population of interest (Cochran, 1977). For example, a project covering 100 miles of highway can be divided into 0.1 mile-long segments in each direction. Then, a random selection process can be utilized to obtain a number of sample segments from the population of 2000 (100 miles*10 segments/directional-mile*2 directions=2000). The results obtained from the sampled portion are then generalized to the whole population at a certain confidence level. To be able to use sampling in the data collection process, road administrators must define the sampling mechanism to be used to draw samples from the population, the equations to be used to determine the portion of the population to be inspected (sample size), and the frequency at which the inspections will be conducted. The reader is referred to another paper (de la Garza, Piñero, & Ozbek, 2008) which presents a detailed sampling procedure for performance-based road maintenance evaluations.

Quality control and quality assurance process. Before the inspections, the implementing agency should prepare a data collection manual which includes the description and pictures of the asset items to be evaluated. Such manual should also have, for each asset item, the specific performance criteria against which the asset item is to be rated. The manual should have pictures of the specific conditions depicting each performance criterion (e.g. a picture depicting a pipe with more than 10% of its diameter closed) for each asset item listed. Then, a training session needs to be held (TRB, 1997). This session should have three components: (i) a classroom component in which the abovementioned manual is discussed with the data collectors, (ii) a field lab component in which the items discussed in the class can be visualized in real life for exercise purposes, and (iii) a test component in which different teams of data collectors are sent to the field to independently evaluate the same asset items; and then their findings are compared through statistical analyses to ensure the consistency in the data collection process. During the inspections, it is suggested to employ a team of experienced and senior personnel (QA/QC Team) to implement quality control and quality assurance once the inspections start. The quality assurance part entails the QA/QC Team to be embedded with the actual data collection crews, spending time with each crew to assure consistent application of the data collection standards. The quality control part entails a random site review to be performed by the QA/QC Team. Within such context, the QA/QC Team will inspect a portion of the sites that were inspected by each crew and the results will be compared to identify whether there are statistically significant differences (TRB, 1997). When the random site review indicates statistically significant differences between the QA/QC Team rating and the data collection crew's rating, the following remediation actions should take place to prevent the similar issues from happening in the future: (i) identify the information that originates the disagreement between the raters, (ii) analyze possible causes for such disagreement, and (iii) discuss the findings with crew members.

Section 3: Data Analysis for LOS Evaluation

Actual performance. The items defined in the framework to evaluate actual performance are as follows: (i) calculation of actual ratings, (ii) comparison of the actual ratings versus the performance targets, (iii) comparison between the different sections (strata) considered in the evaluation, and (iv) comparison between the contractor performance and the agency performance in maintaining the similar portion of roads. To calculate the actual ratings, this research adopted some of the guidelines presented by Stivers et al. (Stivers, et al., 1997). The procedure is as follows:

1. For each asset item, the total number of samples inspected is multiplied by such asset item's weight in order to generate a total possible score (TPS).
2. For each asset item, the number of samples meeting the performance criteria is multiplied by such asset item's weight in order to generate an actual score (AS).
3. For each asset item, the required score (RS) is calculated by multiplying the TPS by the performance target defined for each asset item (as discussed in Section 1 above).
4. Once TPS, AS, and RS are calculated for each asset item (e.g. pipes, paved ditches, unpaved ditches, etc.) belonging to an asset group (e.g. drainage asset group), then such values are added to obtain the TPS, AS, and RS values at the asset group level.
5. The actual LOS rating at the asset group level is obtained by dividing the asset group AS (as calculated in step 4 above) by asset group TPS (as calculated in step 4 above).
6. The required LOS rating at the asset group level is obtained by dividing the asset group RS (as calculated in step 4 above) by asset group TPS (as calculated in step 4 above).
7. The actual LOS rating obtained for each asset group in step 5 is multiplied by the asset group's weight and the results are added to obtain the final overall actual LOS rating for the stratum.
8. The required LOS rating obtained for each asset group in step 6 is multiplied by the asset group's weight and the results are added to obtain the final overall required LOS rating for the stratum.

Long-term performance. Evaluation of the long-term LOS effectiveness of the contractor's maintenance program is crucial in order to identify whether the infrastructure is preserved properly in the long-term. Therefore, two items are included in the framework to evaluate the long-term performance of the contractor. These items are: (i) a comparison of the actual performance versus past performance in the previous year (and previous years-trend analysis) in order to identify areas of concern such as the assets in continuous deterioration and (ii) evaluation and comparison of the long-term effectiveness of maintenance treatments used by the contractor on their corresponding portions of road with those used by the implementing agency.

Section 4: Reporting for LOS Evaluation

Report card. The motivation behind this element of the framework is the report card prepared by the American Society of Civil Engineers (ASCE) for the Nation's Infrastructure. The report card is the simple representation of quantitative results with a grading scale. The grading scale can be established based on the performance targets specified in the contract. For example, the contractor can receive a grade of "A" for an asset group if the actual LOS rating for that asset group is greater than the performance target specified in the contract. If the actual LOS rating is between, let's say, 90% and 95% of the performance target specified in the contract, the contractor receives a grade of "B" for that asset group. The main purpose of developing a report card is to communicate the actual condition of the assets maintained by the contractor in a simple way and identify areas of concern immediately (i.e. assets receiving a C, D, or F).

Report of overall effectiveness of contractor's maintenance program. This report summarizes the performance of the contractor in maintaining the roads. The report not only should detail the contractor performance but also should compare it with the agency's performance. Results from trend analysis as well as the results from the evaluation of the effectiveness of maintenance treatments should be included in this report.

Report of deficiencies to contractor. A more detailed report with the deficient asset items per sample unit should be provided to the contractor. This report should provide the contractor with a comprehensive list of the asset items that failed to meet the performance criteria and their location. This information should be used by the contractor to adjust its maintenance practices (i.e. maintenance treatment types, scheduling and prioritization of maintenance activities, etc.) in order to improve the condition of the deficient asset items as soon as possible. The use of GPS and GIS technology is a suitable approach to support this type of report because it allows the presentation of the information for each sample unit within the roadway system in a user-friendly graphical way.

Component 2: Timeliness of Response (TOR)

Evaluating the timeliness of response of the contractor to service requests is extremely important as it has great implications on the safety of the traveling public. Therefore, road administrators must define, in addition to the technical condition indicators (i.e. performance criteria for LOS effectiveness), measures that establish acceptable response times by asset type and/or service categories. The methodology developed to evaluate the timeliness of response in PBRMC consists of four sections and elements within those sections as discussed below.

Section 1: Input for TOR Evaluation

Road administrators must define measures that establish acceptable response times by asset type and/or service categories. Defining proper response times is extremely important in order to assure that the traveling public has minimum exposure to unsafe environments. Timeliness requirements can be specified for services such as: response to incidents, lane closure, response to complaints, response to emergencies, and snow removal. Timeliness requirements, just like the LOS requirements has the following two components: (i) the performance criteria which establishes the maximum time frame the contractor has when responding to different requests (e.g., twenty minutes response time for incident requests during work hours) and (ii) the performance target which states the acceptable level of compliance with respect to timeliness of response (e.g., 98% of the time the contractor has to meet the twenty minutes requirement for incident requests). These requirements serve as the basis to evaluate the response times of the contractor.

Section 2: Data Collection for TOR Evaluation

The information that needs to be collected for each service request should include the following: time when service was requested, time of arrival, time when setup was finished, description of work performed (e.g., location, type of service, personnel involved), and completion time. Agencies should determine who will be responsible to collect this information; the contractor or the agency itself. Regardless of who keeps the performance reports, it is important to define and implement a very systematic and well-documented process to collect timely, accurate, and reliable information related to the contractors' performance in order to guarantee the success of the monitoring program.

Section 3: Data Analysis for TOR Evaluation

Actual performance. The actual performance of the contractor should be evaluated by conducting at least the following: (i) a comparison of the actual response times versus timeliness requirements, which basically compares the compliance of the contractor on each event to the requirements established in the contract and (ii) a response evaluation of contractor's performance in unexpected events (e.g., storms, and floods).

Long-term performance. The objective of this evaluation is to compare the actual compliance of the contractor to timeliness requirements versus its performance in this area in previous years. By conducting this study, road administrators will have the opportunity to assess the continuous commitment of the contractor in keeping a safer roadway system for the traveling public.

Section 4: Reporting for TOR Evaluation

Similar reports to the ones previously discussed for the LOS evaluation should be produced (Report Card, Deficiencies to Contractor, and Effectiveness of Contractor's Response Process).

Component 3: Safety Procedures (SP)

Highway safety is often stated to be the most important goal by transportation agencies. Therefore, it is required to continuously monitor and evaluate the safety procedures implemented by the contractors of PBRMC. The methodology developed to evaluate the safety procedures in PBRMC consists of four sections and elements within those sections as discussed below.

Section 1: Input for SP Evaluation

Transportation agencies must establish, improve, and clearly communicate the organization's safety policies and safety goals to potential contractors conducting road maintenance activities in order to assure an effective implementation of the safety program. In order to achieve this goal in PBRMC, it is strongly recommended that before transportation agencies establish any contractual agreement for performance-based road maintenance services, they appoint a safety committee who will be responsible to identify safety standards to be considered in the contractor's safety plan, revise and improve additional agency safety requirements, define performance safety measures, define criteria to evaluate the contractor's safety program, and establish the agency safety goals.

Section 2: Data Collection for SP Evaluation

The main objective of data collection is to receive feedback from the personnel that is directly involved with the contractor in conducting regular maintenance activities and also responding to service requests, such as emergencies, road kill removal, traffic control, accidents, and snow removal operations, etc., which requires the implementation of safety procedures. Among the personnel that are in direct contact with the contractor when conducting these activities are police departments, emergency response units, sub-contractors, and DOT safety coordinators. The combination of the evaluations from all these parties can provide the transportation agencies with an overall assessment of the contractor's commitment to safety. These evaluations can be conducted through the use of surveys. When surveys are used as the mechanism to collect data, one must be careful in designing the survey in such a way that the response from the person answering the survey is not biased by how the questions are structured. It is the responsibility of the survey designer to clearly specify the objectives of the survey, the different areas to be evaluated, and the scoring system to be used to evaluate each area (e.g., 100% to 95%-Excellent, 95% to 80%-Good, 80% to 70%-Fair, and < 65%-Poor). The reader is referred to Stivers et al. (Stivers, et al., 1997) for guidelines on designing efficient surveys and determining acceptable response rates for the case of highway maintenance.

Section 3: Data Analysis for SP Evaluation

The framework promotes the evaluation of five areas to assess the performance of contractors with respect to their safety programs. These five areas are discussed below.

Management. In general, this area examines the commitment and involvement of the contractor's managers in the development and enforcement of a safety program. This evaluation determines: (i) if the contractor defines strategic and action plans to address safety issues, (ii) if adequate personnel is designated and empowered by the contractor to coordinate and monitor the safety management process, and (iii) if proper coordination, communication, and cooperation is provided by the contractor's safety personnel.

Training program. The main objective of this area is to examine whether the contractor provides an effective safety orientation and training program to in-house crews and also to sub-contractors with the objective of increasing safety knowledge and consciousness (e.g., potential hazards and safer work practices), and safety skills (e.g., proper handling of equipment).

Implementation (operational procedures). This area examines if the contractor and sub-contractors perform road maintenance procedures (including winter maintenance) according to national and statewide safety related standards and according to the safety strategic plan.

Documentation. This area examines the contractor's capabilities in collecting accurate incident records and safety inspections as a part of an ongoing safety review process.

Innovation. This area examines the willingness of the contractor to search for improved means and methods to ensure more effective safety practices such as better traffic control devices and techniques, better management of work zone operations, and reduction of work durations (promotes less exposure of traveling public to hazardous environments).

Section 4: Reporting for SP Evaluation

Similar reports to the ones for the LOS and TOR but with a focus on the overall effectiveness of the contractor in implementing acceptable safety procedures should be produced.

Component 4: Quality of Services (QOS)

This component assesses the customers' (road users, transportation agency, and sub-contractors), perceptions and satisfaction with respect to the condition of the assets and contractor performance. The methodology developed to evaluate the quality of service in PBRMC consists of four sections and elements within those sections as discussed below.

Section 1: Input for QOS Evaluation

Understanding the customers' needs is essential for the success of any transportation program. Customers are the ultimate evaluators of the services and thus it is very important for the transportation agencies to assess the customers' needs by conducting surveys, public meetings, etc (TRB, 1997).

Section 2: Data Collection for QOS Evaluation

The same methodology (i.e., surveys) used to collect information with respect to the contractor's safety performance is recommended to collect the information to assess the perception of the quality of services provided by the contractor. The objective is to collect data from the individuals that work together with the contractor as well as from the individuals that are impacted by the contractor's work. The parties that are identified as valuable sources of information are the traveling public, emergency response units, sub-contractors, and DOT contract administrators and supervisors.

Section 3: Data Analysis for QOS Evaluation

Data analysis will be performed with respect to different surveys sent to different parties as discussed below.

Traveling public survey. This survey examines the perspective of the users with respect to their satisfaction about the ways in which maintenance activities are executed.

Emergency and highway patrol units survey. The main objective of this survey is to examine the overall satisfaction of the emergency and highway patrol personnel with respect to contractor's efforts such as the timeliness of response to emergencies and the implementation of strategic plan to address emergency events.

Sub-contractors survey. This survey examines the opinion of the sub-contractors that perform work for the contractor with respect to the fairness of the procurement process used to adjudicate contracts to perform maintenance works (e.g., opportunity to bid on the works in a fair and competitive manner, proper discussion of the nature of the work in the contract, etc.) In addition, the survey also examines the sub-contractors' experiences on how the contractor administers the contracts (e.g., supervision, dispute avoidance, and payment compliance).

Road administrators survey. This survey examines the satisfaction of road administrators with respect to the general performance of the contractor. These individuals work with the contractor in a daily basis, and thus they are excellent resources to provide feedback on the commitment of the contractor to provide services to public.

Section 4: Reporting for QOS Evaluation

Similar to previous components, a Report Card must be produced to help communicate the results from the analysis. Furthermore, a report that compares the results from the quality of services satisfaction with the results from the analysis of the other components of the framework is recommended. Such report can be used to identify whether the findings from the first four components of the framework are in accordance with the overall customer perception of the quality of services as provided by PBRMC.

Component 5: Cost Efficiency (CE)

The main objective of this component is to assess the cost-efficiency of PBRMC by comparing the price of the work done by the contractor with the price of the work if it is contracted out through traditional methods or self-performed by the implementing agency. A combination of cost estimating techniques and probability analysis has been incorporated in the structure of this component in order to meet this objective. Only a general description of the methodology is presented here due to space limitations. The reader is referred to another publication (Piñero, 2003) for a detailed explanation of these techniques. The methodology developed to evaluate the cost efficiency in PBRMC consists of four sections and elements within those sections as discussed below.

Sections 1 and 2: Input and Data Collection for CE Evaluation

Agency historic and actual bid prices for subcontracted work. Transportation agencies must identify bid price tabulations for each maintenance activity that is contracted to the industry through traditional methods. Different sources such as agencies' historic bid tabulations as well as private institutions that record bid tabs from DOT jobs can be used to get this information. The goal is to use this data as the input to estimate what the prices would have been if the work done by the performance-based road maintenance contractor was sub-contracted to companies that bid the jobs administered by the transportation agency through traditional methods.

Agency historic and actual expenditures for self-performed work. Similar to the identification of bid price tabulations, records of the agency maintenance expenditures for self-performed work are required. Sources such as the Accounting Management System (AMS) and Maintenance Management System (MMS) are available in transportation agencies to obtain this information. These systems keep track of the expenditures associated to self-performed work. However, one must be careful when using the information from these systems because sometimes this information has not been captured in the proper way. In order to perform a reliable and valid comparison, it is crucial that the unit prices used be consistent and composed of the appropriate cost components.

Contractor's maintenance work done in PBRMC. A database with all the bid tabs of all the works performed by the contractor is required to implement the cost analysis approaches adopted in the framework. This

database must provide information about the bid date, contract location, bid item or activity description, bid quantities, bid prices, and total cost.

Section 3: Data Analysis for CE Evaluation

The data analysis is divided into two stages: (i) assessment of agency prices if the work is performed under traditional maintenance contracting and (ii) study of LOS versus Expenditures. With respect to the first stage, two different approaches are defined in the framework to conduct this study: (i) the distribution approach and (ii) the regression approach. Once the results from analysis in stage one are obtained, then the analysis for the stage two, LOS versus Expenditures, can be performed. The main objective of this analysis is to evaluate the impact on the level of service (condition of the roadway system) if the implementing agency spends on maintenance at least the same amount of money as the contractor working under the terms of PBRMC does. The Bayes Theorem is adopted in the framework to relate cost to performance and to analyze the impact of maintenance expenditures on LOS.

Section 4: Reporting for CE Evaluation

The reporting section for this component consists of presenting a comparison of the findings obtained from both approaches and also the findings from the study of LOS versus Expenditures discussed in the previous section.

Concluding Remarks

This paper presented a framework developed to provide road administrators with a reliable and comprehensive methodology to monitor PBRMC. The framework suggests the assessment of five main areas in order to ensure the reliability and comprehensiveness of the evaluation process. The major contribution of this framework is to provide transportation agencies with guidelines for evaluating the effectiveness and efficiency of PBRMC as an alternative delivery method to maintain and preserve the road infrastructure. Development of the complete framework was finalized in 2002. 2002 through 2007, it has been implemented once/year to monitor the performance-based road maintenance contract (which covered about 250 miles of interstate) that Virginia Department of Transportation (VDOT) implemented as a pilot project. As a result of this pilot project, and with appropriate legislation (i) in 2007 VDOT decided to outsource 100% of its interstate maintenance using performance-based road maintenance contracts and (ii) in 2007 VDOT decided to use this framework to monitor all of its performance-based road maintenance contracts. Specifically, this framework was implemented 8 times (for different contracts) in 2008; in 2009 it will be implemented for 13 times.

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