Abstract: The Virginia Department of Transportation’s (VDOT) first performance-based road-maintenance contract was concluded in July 2007. This contract required the contractor to maintain all assets and carry out incident management and snow and ice removal services on a total of 250 mi (402 km) of a number of Virginia’s interstate highways. This contract acted as a pilot project for VDOT and other state departments of transportation (DOT). Since performance-based road-maintenance contracting is rather new and yet to be utilized by many state DOTs, there is an emerging need to (1) assess whether its use is viable, and (2) inform the state DOTs of the key issues to consider when using performance-based road-maintenance contracting. The purpose of this paper is to address this need by providing a comprehensive evaluation of VDOT’s overall experience with its pilot performance-based road-maintenance contract. The findings from the analyses over a period of 6 years indicate that while meeting or coming very close to the performance targets most of the time, there have been years in which the contractor was not able to meet performance targets in fence-to-fence asset groups and bridges. As far as the comparison of the level-of-service effectiveness performance of the contractor with that of VDOT utilizing traditional maintenance approaches is concerned, our findings show that the contractor outperformed VDOT in fence-to-fence asset groups. The key issues that a state DOT should consider when using performance-based road-maintenance contracting, as learned from VDOT’s pilot project experience, can be summarized as (1) tying payments to be made to the contractor to actual performance, (2) generating a detailed baseline condition information, (3) using performance targets that increase (as opposed to being constant) over the contract period, (4) establishing a performance target for every single item required to be maintained, (5) having multiple inspections per year, (6) developing a standard rating procedure for all elements, and (7) developing objective, quantifiable, and easily measurable performance criteria. DOI: 10.1061/(ASCE)TE.1943-5436.0000294.

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Introduction and Background

In July 1995, the Public-Private Transportation Act (PPTA) of Virginia was passed. This act authorized the Commonwealth of Virginia (responsible public entity) to establish contracts with private entities to acquire, construct, improve, maintain, and operate one or more transportation facilities within the state of Virginia. PPTA further states that this approach of privatization may result in the availability of such transportation facilities to the public in a more timely or less costly fashion (Code of Virginia 1995).

Three months after PPTA was passed, in October 1995, a private contractor submitted an unsolicited proposal to the Virginia Department of Transportation (VDOT) for the maintenance of assets within a portion of the interstate highway system of Virginia. After an intensive evaluation of this proposal by VDOT (including the phases of a detailed proposal resubmittal by the contractor and negotiations), in December 1996, the contract, “Comprehensive Agreement for Interstate Highway Asset Management Services,” was signed. The contract required the contractor to maintain all assets and carry out incident management and snow and ice removal services on a total of 250 mi (402 km) of a number of Virginia’s interstate highways (I-77, I-81, I-95, and I-381). By this contract, a total of 20% of Virginia’s interstate highways were covered. This was a lump-sum 5.5-year contract with an option of renewal for one more term, and with a total fee of $131.6 million. Furthermore, the contract was renewed in June 2001 for five more years (contract term to commence in July 2002, and end in July 2007) at a fixed-fee of $162 million, with contract provisions (other than the fee) remaining exactly the same as the previous term’s.

A very important aspect of the contract between VDOT and the contractor is its performance-based nature. In traditional road-maintenance contracts, transportation agencies specify how the work is going to be undertaken. A performance-based road-maintenance contract, on the other hand, sets forth the performance expected from the end product of a project, rather than specifying the materials or methods to be used. In other words, a performance-based road-maintenance contract specifies the desired final product rather than the processes to reach that product.
typically performance-based road-maintenance contracts: (1) cover long road sections (e.g., a long corridor of the network, an entire county or district of the transportation agency); (2) are long-term (3–5 years with the option of multiple renewals); and (3) focus on all of the asset items within the right-of-way fences (de la Garza et al. 2009a). These characteristics of performance-based road-maintenance contracts typically lead to three significant results. First, the risk of maintenance design problems (with respect to the selection of materials and workmanship) is transferred to the contractor. Second, the contractor often seeks innovative methods to perform maintenance. Last, the contractor typically adopts a lifecycle costing approach while planning the maintenance of multiple assets during the long duration of the contract (Hardy 2001; Porter 2001; Zietlow 2002).

Another important aspect of the contract is that it is an asset management contract. As Falls et al. (2001) state, asset management is "a systematic process of maintaining, upgrading, and operating physical assets cost-effectively." Asset management is a comprehensive and well-structured approach to the long-term management of assets to provide effective and efficient services to the community. Asset management does not elaborate on a singular system within the highway (e.g., pavements and bridges), but examines all components to allow for the effective management of resources, to make effective investments, and to decrease overall costs (JLARC 2002). Along the lines of these definitions, the aforementioned contract makes the contractor in charge of maintaining all assets between VDOT’s right-of-way fences within the sections of the interstate highway system covered by the contract (JLARC 2001). This includes all road surfaces, roadside, drainage, traffic assets, and bridges.

Need, Purpose, and Objectives

Being a performance-based asset management contract, the aforementioned contract was very different from other highway maintenance contracts issued in Virginia and in other states. It should be noted that VDOT has been one of the first state agencies that took the initiative of using a performance-based asset management contract for the maintenance of a portion of its interstate highway system (Ozbek 2004). Hence, this contract acted as a pilot project for VDOT and other states’ departments of transportation (DOT). Since performance-based road-maintenance contracting is rather new and yet to be utilized by many state DOTs, there is an emerging need to (1) assess whether its use is viable and (2) inform the state DOTs of the key issues to consider when using performance-based road-maintenance contracting.

The purpose of this paper is to address this need by providing a comprehensive evaluation of VDOT’s overall experience with its pilot performance-based road-maintenance contract. Within this context, this paper has three main objectives. First, an analysis of the performance of the contractor is performed over multiple years with respect to (1) the level-of-service effectiveness achieved in maintaining asset items (under the categories of fence-to-fence asset groups, roadway, and bridges, as discussed subsequently and as shown in Table 1), and (2) timeliness of response achieved in making the repairs in a timely manner. Furthermore, while performing the analysis for the fence-to-fence asset groups, this paper compares the level-of-service effectiveness performance of the contractor working under the terms of the performance-based asset management contract with that of VDOT utilizing traditional maintenance approaches in other sections of the interstate system, which were used as control sections for the duration of this research project. Those control sections were exposed to similar external conditions (e.g., traffic volumes and climate) to the contractor’s sections and had similar baseline conditions at the beginning of the contract term to the contractor’s sections. Such external conditions are beyond the control of the maintenance provider (whether the contractor or VDOT) and highly affect both the maintenance efforts (e.g., maintenance time restrictions on roads with high traffic volumes) and deterioration of the highway (e.g., fast deterioration rates on roads with high traffic volumes). Therefore, to address this important issue and to ensure a fair comparison between the contractor and VDOT, the selection of control sections was performed by VDOT by taking all uncontrollable factors into consideration. Finally, this paper discusses the lessons learned as a result of this pilot project to point out the key issues to consider when using performance-based road-maintenance contracting.

Scope

Since the inception of the pilot project, VDOT has investigated ways to evaluate the contractor’s performance. However, a study conducted by Joint Legislative Audit and Review Commission of the Virginia General Assembly (JLARC) in 2000 concluded that VDOT had not been able to develop a solid measurement system as far as the contractor’s performance is concerned. Furthermore,
Components of Analyses

As discussed earlier, one of the objectives of this paper is to perform an analysis of the performance of the contractor over multiple years with respect to: (1) the level-of-service effectiveness achieved in maintaining asset items, and (2) timeliness of response achieved in making the repairs in a timely manner. Furthermore, the level-of-service effectiveness component will also be used to compare the performance of the contractor with that of VDOT for fence-to-fence asset groups. Both components of analyses (i.e., level of service and timeliness of response) are subsequently discussed briefly just to introduce the main concepts beyond the analyses that will be performed throughout the rest of the paper. Further information about various analyses will also be provided within their respective sections. The reader is referred to other papers (de la Garza et al. 2008, 2009a), which discuss the performance measurement framework (i.e., procedures for data collection, data analysis, and reporting) for measuring the level-of-service effectiveness and the timeliness-of-response performance in more detail.

Level-of-Service Effectiveness

This component investigates how well the highway is maintained (by the performance-based road-maintenance contractor or VDOT) by using the performance criteria that are defined for each asset item existing within the right-of-way fences of a highway system. Level of service for the pilot project within the scope of this paper was investigated for three main elements that are defined to exist within such right-of-way fences, the evaluation details of which are shown in Table 1 and discussed subsequently.

As can be seen in Table 1, there are three sources to obtain the data for the level-of-service component (Ozbek 2007):

(1) Maintenance rating program (MRP) inspections: These are the inspections performed once every year by the field crews to identify whether an asset item meets the predefined performance criteria. For example, for the guardrail asset item, such criteria are (1) being free of rust that would affect the structural integrity, (2) being free of dents that would affect the structural integrity, (3) meeting the height criteria, and (4) having the posts in good condition (Ozbek et al. 2009). Field crews are composed of experienced inspectors who have been performing these inspections for a long time. Such field crews go through a well-structured training each year before the inspections. Furthermore, during the inspections, these field crews are made subject to very strict quality assurance and quality control programs. MRP does not call for 100% inspection of the highway sections but rather uses robust statistical techniques to sample the populations [by using 0.1-mile (0.16-km) long segments] and to derive findings that can be generalized to the entire highway sections at the 95% confidence level. The reader is referred to other papers (de la Garza et al. 2008, 2009a), which discuss the inspections and the accompanying statistical procedures.

(2) VDOT’s pavement management system: This is the program that is used by VDOT to assess the condition of the roadway in a given year to be able to make budgetary decisions for the next years. As a part of this program, VDOT field crews travel through the state and collect data pertaining to the load-related distress rating (LDR), non-load-related distress rating (NDR), and international roughness index (IRI). LDR is an index that depicts the state of the roadway from the perspective of the damage attributable to the traffic load. This index, as assigned to the roadway by inspectors based on visual inspection, ranges from 0 to 100, with the latter corresponding to the best condition. NDR is an index that depicts the state of the roadway from the perspective of the damage attributable to the climate-related issues such as temperature and moisture change over time. This index, as assigned to the roadway by inspectors based on visual inspection ranges from 0 to 100, with the latter corresponding to the best condition. VDOT has also defined another index, critical condition index (CCI), which is the lower of either LDR or NDR. VDOT uses that index (as opposed to the LDR or NDR) to identify the deficient sections of the roadway, as that index simply shows the critical condition of the roadway (JLARC 2002). IRI is an indicator of overall pavement smoothness. The data are collected using an instrumented vehicle that measures the road surface roughness in inches (or meters) of vertical deviation per mile (or kilometer) of the traveled road. Smaller IRI values indicate a better road surface. This index may range from 0 to an upper value with no theoretical limit, with the former corresponding to the best condition (JLARC 2002).

(3) National Bridge Inventory (NBI) Program: The data for bridges are gathered by VDOT’s Asset Management Division as a part of the federally-mandated NBI process and thus are well-documented. These data are provided to the Federal Highway Administration and kept in its database, to be used to establish investment requirements, to develop data summaries at the national level for reports to Congress, and to respond to inquiries from entities such as Congress, the National Transportation Safety Board, and others (ESRI 2004).

Timeliness of Response

This component investigates whether the contractor is able to provide the timely repair of certain highway asset items (such as guardrails, signs, and impact attenuators) as per the timeliness criteria defined in the contract for safety’s sake (Ozbek et al. 2009). For assessment of the contractor with respect to this component, inspectors identify whether the repair of a certain damaged asset item is performed within the predefined time frame established in the contract as one of the performance criteria. For example, the
timeliness-of-response criteria for the guardrail asset item are as follows: (1) damaged and nonfunctional guardrails should be replaced within 48 h of notification, and (2) damaged but still functional guardrails should be replaced within 1 week of notification. It is important to note that not every single asset item has a timeliness criterion. Rather, the contract lists a few asset items (as will be discussed subsequently) to have timeliness criteria for the sake of the safety of the traveling public.

Analysis of the Performance of the Contractor

The first part of this section presents the analysis of the performance of the contractor over the time period of 2002–2007 with respect to its level-of-service effectiveness. For the fence-to-fence asset groups, a comparison of the contractor’s and VDOT’s performance is also provided. The second part of this section presents the analysis of the contractor’s performance with respect to the timeliness of response achieved in making the repairs in a timely manner.

Level-of-Service Effectiveness Performance of the Contractor

The analysis for the level-of-service effectiveness is divided into three parts, because of the nature of the data collected for three main elements as shown in Table 1: (1) Fence-to-fence asset groups, (2) roadway, and (3) bridges. The discussion for each follows:

Level of Service for Fence-to-Fence Asset Groups

The data collected in MRP inspections are analyzed using a bottom-up approach, starting with computing the passing rate (i.e., the percentage that meets the predefined performance criteria) at the asset-item level per route, then at the asset-group level per route, and finally at the asset-group level for all routes. For each year of analysis, a weighing approach is used to be able to roll up the data collected at the asset item level to the aforementioned aggregate levels. The aforementioned computations are done both for the routes maintained by the contractor, and the control sections maintained by VDOT utilizing traditional approaches. Furthermore, VDOT’s performance target for the contractor (i.e., the percentage that is required to meet the predefined performance criteria as per the contract) at the each asset group level for all routes is also calculated using a similar weighing approach. These weighing approaches are developed using a National Cooperative Highway Research Program study (Stivers et al. 1999), which calls for the assignment of weights to different highway elements based on the importance of those elements as perceived by the transportation agency. For further information on the weighing approaches, the reader is referred to de la Garza et al. (2009a) and Ozbek et al. (2010a). The results of this analysis for each asset group (i.e., shoulders, roadside, drainage, and traffic) are shown in Figs. 1–4.

Some important findings from the analysis of the results for the fence-to-fence asset groups are as follows:

1. For the shoulders and the traffic asset groups, the contractor was able to meet VDOT’s performance targets all throughout the period of analysis;
2. For the roadside and drainage asset groups, there were years in which the contractor’s performance fell below the performance targets. The contractor’s performance was below targets for both asset groups during the same years (i.e., 2003, 2004, and 2007);
3. For the roadside and drainage asset groups, once the contractor’s performance dropped below the targets in 2003, the contractor made an effort to increase the condition of those asset groups in 2004 and went above the performance targets in 2005. However, the condition of those asset groups started to deteriorate after 2005 and eventually went below the performance targets in 2007;
4. The contractor maintained the shoulders asset group at a certain performance level (around 98%) throughout the period of analysis. However, for the other three asset groups, there were changes in the performance level in both ways (i.e., performance increase and decrease) throughout the period of analysis; and
5. For the shoulders asset group, both the contractor (with performance-based maintenance approach) and VDOT (with traditional maintenance approach) always met the performance targets over the period of analysis. For the roadside asset group, the contractor met the performance targets for 3 years, while VDOT never met the performance targets over the period of analysis. For the drainage asset group, the contractor met the performance targets for 3 years, while VDOT never met the performance targets over the period of analysis.

![Fig. 1. Level-of-service effectiveness for the shoulders asset group](image_url)
For the traffic asset group, the contractor always met the performance targets over the period of analysis, while VDOT met the performance targets for 2 years (also note that in 2006, VDOT’s rating was barely below the performance target).

Level-of-Service for Roadway

The CCI and IRI data (as explained previously) obtained from VDOT’s Pavement Management System are used to perform the level-of-service analysis for the roadway. VDOT, for the roadway element, did not set any performance target for the contractor to achieve. Rather, VDOT wanted the contractor’s performance to be reported using certain categories (e.g., excellent, good, fair, poor, and very poor) in terms of CCI and IRI. Therefore, different from the case of fence-to-fence asset groups, this analysis does not include any comparison against predefined targets. Furthermore, the analysis for the roadway does not include any comparison between the contractor’s and VDOT’s performances. This is mainly because there is no yardstick (i.e., performance target as in the case for fence-to-fence asset groups) on which such a comparison can be based. Figs. 5 and 6 present the results for the CCI and IRI analysis for the contractor, respectively. In those figures, for each year of analysis, the percentage of the roadway miles (or kilometers) that is identified to be in excellent, good, fair, poor, and very poor condition based on the CCI and IRI indexes is presented for the routes maintained by the contractor.

Since no performance target was specified for the roadway, it is not possible to reach an overall conclusion about the contractor’s performance for this element. Nevertheless, it can be stated that the contractor was able to keep more than 65% and 85% of the roadway miles (or kilometers) at excellent or good condition with respect to CCI and IRI, respectively, throughout the period of analysis.

Level-of-Service for Bridges

NBI data is used to perform the level-of-service analysis for the bridges. For bridges, the performance target for the contractor was set by VDOT as follows: the NBI rating for each subelement.
of the bridges maintained by the contractor (i.e., deck, superstructure, substructure, and slope protection) needs to be equal to or more than what it was at the beginning of the contract term. Therefore, VDOT’s target for each subelement of the bridges is the NBI rating of such subelement at the beginning of the contract term. Fig. 7 presents the results of the analysis for the contractor. In Fig. 7, for each year of analysis and for each subelement, the overall NBI rating of all the bridges maintained by the contractor is shown. Furthermore, Fig. 7 also shows the VDOT performance target set for the contractor for each subelement of the bridges. Given that the performance target set by VDOT for each bridge subelement is stated in terms of the initial condition of the bridges maintained by the contractor and not as an absolute value as in the case of fence-to-fence asset groups (e.g., 90% for shoulders as shown in Fig. 1), this analysis for the bridges does not include any comparison between the contractor and VDOT’s performances.

Some important findings from the analysis of the results for the bridge element are as follows:

1. The performance target for the slope protection subelement was never met during the period of analysis, even though the performance level attained in each year was not significantly lower than the performance target;
2. The contractor was able to meet the performance target for the substructure all throughout the period of analysis;
3. For the superstructure, while coming very close, the contractor was not able to meet the performance target up until the last year of the contract term. In 2007, the performance target was met; and
4. For the deck, the contractor both went above and below the performance target throughout the period of analysis.

While this analysis provides a macrolevel insight for the performance of the contractor with respect to the bridges, given the...
strategic importance of bridges, analyses at more disaggregate levels (e.g., at the individual bridge level) are warranted, as discussed in the “Conclusions and Future Research” section of this paper.

Timeliness-of-Response Performance of the Contractor

This section presents the analysis of the contractor’s performance with respect to the timeliness-of-response achieved in making the repairs in a timely manner as per the timeliness criteria defined in the contract. Asset items that have timeliness criteria are guardrails, impact attenuators, highway lighting, signs, truck ramps, traffic safety features on bridges, and roadways (for the repair of potholes only). The timeliness criteria range from 1 h to 1 week, depending on the asset item.

For the assessment of the contractor with respect to this component, inspectors identify whether the repairs of the damaged asset items listed previously are performed within the predefined time frames established in the contract. Then, the timeliness-of-response rating, which represents the percentage of such repairs that were completed in that time frame, is calculated.

Fig. 8 presents the results of the timeliness-of-response analysis for the contractor for each year of analysis. VDOT, for the timeliness-of-response component, did not set any performance target for the contractor to achieve. Therefore, our analysis does not include any comparison against predefined targets. Furthermore, no timeliness-of-response data was collected for the repairs performed in the control sections (i.e., the sections where the road maintenance is performed by VDOT utilizing traditional maintenance).
Therefore, our analysis for the timeliness-of-response component does not include any comparison of performance-based with traditional maintenance (as was done for the level-of-service effectiveness component).

As can be seen in Fig. 8, in 2003, the contractor’s timeliness-of-response rating was low, at just below 50%. Other than in that one year, the contractor’s performance with respect to meeting the timeliness-of-response criteria was at a minimum of 80% and reached as high as 95% in 2006.

Lessons Learned from VDOT’s Pilot Performance-Based Road-Maintenance Contract

This section discusses the lessons learned from VDOT’s pilot performance-based road-maintenance contract. This information can be used by VDOT for managing its subsequent performance-based road-maintenance contracts and by any other state DOT considering utilizing performance-based contracting for road maintenance.

The most important lesson learned is the need for tying payments to be made to the contractor to actual performance. Even though the contract gave the right to VDOT to withhold payment from the contractor for not meeting performance targets, an explicit relationship linking the payment to the performance of the contractor was not defined in the contract. This created a lot of difficulty for VDOT at times when VDOT wanted to withhold a certain amount of payment because of the contractor’s poor performance. Since there was no explicit relationship linking payments to the performance, the amount tried to be withheld was challenged by the contractor. Therefore, the performance-based road-maintenance contract should have a section discussing the mechanism to be used for determining the exact amount of payments to be made to the contractor, based on its ability to meet the performance targets. This mechanism can be based on the ratings attained at the asset item, asset group, or at the network level. VDOT started implementing such a system with its performance-based road-maintenance contract released in 2010.

Another issue was the lack of the detailed baseline condition information of the network, to be maintained by the performance-based contractor (with the exception of bridges). It would be desirable to perform a baseline inventory and condition assessment for the entire roadway section covered by the performance-based contract before issuing such a contract. This will allow a state DOT to understand the existing conditions of the roadway and furthermore, to provide the potential bidders with such information to be utilized while generating their work plan and estimates for the long-term contract they are pursuing. Knowing the condition information of the asset items before the beginning of the contract term can also help the state DOT establish realistic and dynamic performance targets, as opposed to constant performance targets. In other words, the state DOT may require the contractor to improve the condition of the asset items continuously throughout the contract term by setting a rather low (which is still reasonably above the baseline condition) performance target for the first year and then increasing that target in the subsequent years. With the increasing performance targets, the state DOT can assure that the condition of the highway system is improved over the term of the performance-based contract, as opposed to being kept at a certain level. The pilot project tried to achieve this by introducing a “comparative performance target” for the bridges element. As discussed previously, the performance target for the bridges was stated to be equal to or more than what it was at the beginning of the contract term. Even though this performance target considers the baseline condition of bridges, it does not promote a continuous improvement as the contractor can just keep the condition at the baseline level and still be in compliance with the performance target.

As discussed while presenting the findings from analyses, the contract did not establish any performance target for the roadway level of service and the timeliness of response. This precluded VDOT from drawing conclusions about the performance of the
contractor for those items as there was no yardstick against which to measure the performance. To address this issue, the contract should establish, for every single item required to be maintained by the contractor, not only the performance criteria but also a performance target that the contractor is required to meet.

The pilot project called for yearly inspections to assess the performance of the contractor in maintaining the asset items. That is why the analyses presented in this paper are done yearly. Nevertheless, if the state DOT has available resources (as the funds to perform the inspections are provided by the state DOT), it would be better to have at least two inspections per year to capture the effects of seasonal variations (e.g., in climate and traffic) on the condition of the asset items and thus the performance of the contractor. Multiple inspections per year would also motivate the contractor to be more diligent in performing maintenance of all asset items continuously so as not to fall below the performance targets anytime throughout the year. VDOT started implementing a 2–3 inspections/year scheme with its performance-based road-maintenance contract released in 2010.

Three different sources of data (as listed in Table 1) and three different methods were used to assess the level-of-service effectiveness of the contractor for different elements (i.e., fence-to-fence asset groups, roadways, and bridges). It is more desirable to utilize a standard rating procedure for all elements. It is suggested that the state DOTs define the performance criteria for the roadways and bridges in a similar manner to the one used for the fence-to-fence asset groups, thereby resulting in the computation of the passing rate (i.e., the percentage that meets the predefined performance criteria) to report performance of the contractor in a standard and simpler way for all elements. VDOT started using standard performance criteria and standard performance reporting procedures for all elements with its performance-based road-maintenance contract released in 2006.

The language of the performance criteria as used in the pilot project can be interpreted differently by different parties. For example, one of the performance criteria for the paved ditches asset item is “having no undermining or undercut that requires action.” The phrase “that requires action” can be interpreted differently by different individuals, resulting in confusions and disagreements over the performance of the contractor (Ozbek 2004). To address this issue, performance criteria should be revised to ensure that they are not subject to different interpretations. Even though there is inherent subjectivity in the condition assessment process as performed by the field crews, such subjectivity can be minimized by the introduction of objective, quantifiable, and easily measurable performance criteria. Another performance criterion for the paved ditches asset item, which is “having less than 1 in. of settlement,” is a good example of an objective, quantifiable, and easily measurable performance criterion that is not subject to different interpretation by different individuals.

Conclusions and Future Research

There are a handful of states (e.g., Virginia, Texas, Florida, North Carolina, and Washington, D.C.) that have been experimenting with performance-based contracting for the maintenance of their roads. There are other states which are considering trying such a contracting approach. It is reasonable to assume that the experience of the states that have already utilized performance-based road-maintenance contracts can be of value for the states that are considering using this approach.

Within this context, this paper strived to provide a comprehensive evaluation of VDOT’s overall experience with its pilot performance-based road-maintenance contract. This evaluation included (1) an analysis of the performance of the contractor over multiple years with respect to its level-of-service effectiveness and timeliness of response, (2) a comparison of the level-of-service effectiveness performance of the contractor with that of VDOT utilizing traditional maintenance approaches for fence-to-fence asset groups, and (3) the discussion of the lessons-learned as a result of this pilot project, to point out the key issues to consider when using performance-based road-maintenance contracting.

The findings from the analyses over a period of 6 years indicate that while meeting or coming very close to the performance targets most of the time, there have been years in which the contractor was not able to meet performance targets in fence-to-fence asset groups and bridges. Since no performance target was specified for roadways, it is not possible to reach an overall conclusion about the contractor’s performance for this element. Nevertheless, it can be stated that the contractor was able to keep more than 65% and 85% of the roadway miles (or kilometers) at excellent or good condition with respect to CCI and IRI, respectively, throughout the period of analysis. Just as in the case for the roadway, no performance target was specified for the timeliness of response, and thus an overall conclusion about the contractor’s timeliness-of-response performance cannot be reached. Nevertheless, it can be stated that the contractor attained at least an 80% of timeliness-of-response rating with the exception of one year in which the rating was just below 50%.

The findings with respect to the level-of-service performance of the contractor are presented at a high level in this paper. The data collected at the subelement level as shown in Table 1 (e.g., roadside, deck) is then rolled up to higher (and thus more aggregate) levels using certain aggregation methods as discussed by de la Garza et al. (2009a) and Ozbek et al. (2010a). This was done to be able to identify and present the overall performance of the contractor in maintaining the different portions of the interstate highways under its jurisdiction. It is acknowledged that such an aggregation process may result in hiding the instances in which the contractor might have underperformed (i.e., did not meet the performance targets). For example, there could be an instance in which the contractor may have not met the performance target with respect to the deck subelement in a route (e.g., I-77), whereas the contractor was above the performance target with respect to the deck subelement in all other routes it maintained. Aggregating the data from all routes may result in an overall performance that is better than the performance target with respect to the deck subelement. In other words, when the analysis is made to identify the overall performance of the contractor, the specific instances where the contractor did not meet the performance target may be masked. For the purposes of this paper, we presented the analysis that is performed at the aggregate level to be able to discuss the overall performance of the contractor. Nevertheless, the reports that were provided to VDOT each year present the results in multiple levels (by using a bottom-up approach), to allow VDOT to make appropriate decisions with respect to the performance of the contractor at different levels.

As far as the comparison of the level-of-service effectiveness performance of the contractor with that of VDOT utilizing traditional maintenance approaches is concerned, our findings show that the contractor outperformed VDOT in fence-to-fence asset groups. In that comparison, VDOT was held to the same performance criteria to which the contractor was held. In other words, to assess the performance of VDOT, the field crews utilized the same performance criteria for each asset item both for the contractor and VDOT while performing the inspections. Even though the entities of comparison may not be in the same mode of operation as far as the budget constraints, the length of contract, and flexibility in performing the maintenance services are concerned, such a
comparison allows identification of the mode of operation (i.e., performance-based road-maintenance or traditional road maintenance), leads to more desirable results.

The key issues a state DOT should consider when using performance-based road-maintenance contracting, as learned from VDOT’s pilot project experience, can be summarized as (1) tying payments to be made to the contractor to actual performance, (2) generating a detailed baseline condition information, (3) using performance targets that increase (as opposed to being constant) over the contract period, (4) establishing a performance target for every single item required to be maintained, (5) having multiple inspections per year, (6) developing a standard rating procedure for all elements, and (7) developing objective, quantifiable, and easily measurable performance criteria.

Even though this research made an attempt to evaluate VDOT’s overall experience with its pilot performance-based road-maintenance contract in an effort to provide state DOTs with information related to the (1) viability of performance-based contracting for road maintenance, and (2) key issues to consider when using performance-based road-maintenance contracting, its scope is limited to the pilot project that was discussed herein. While the lessons learned and key issues discussed in this paper can be applicable to other states and other contracts, the findings with respect to the contractor’s performance and its comparison with that of traditional maintenance are limited to the project that was discussed herein and are just meant to provide preliminary information on performance-based road-maintenance contracting and its viability. Only with more research that gathers data from other cases of performance-based road-maintenance contracting from VDOT and other state DOTs can more generalizable findings be derived. As of 2010, VDOT has 100% of its Interstate system maintained through performance-based road-maintenance contracting. Future research could use the multiple contracts issued by VDOT as additional data points in trying to draw further conclusions about the viability of performance-based road-maintenance contracting.

While this research performed a comparison of performance-based and traditional maintenance approaches from the level-of-service effectiveness point of view, the actual amount of resources expended by both maintenance approaches, in attaining that level of service was not investigated. To be able to have a more comprehensive comparison, the cost-efficiency of both approaches, in addition to level-of-service effectiveness attained by both approaches, should be investigated. Ongoing research addresses the cost-efficiency of both approaches, and initial findings show that the traditional highway maintenance and the performance-based approach can be equally efficient (de la Garza et al. 2009b).

Finally, even though this research, in making the comparison between performance-based maintenance and traditional maintenance, tried to generate a level playing field by making sure that the road sections selected as the control sections are exposed to similar external conditions (e.g., traffic volumes and climate, as the contractor’s sections and have similar baseline conditions at the beginning of the contract term to the contractor’s sections), such external/baseline conditions were not explicitly taken into consideration during the comparison. Future research should develop models that can explicitly take such external/baseline conditions into account while making the comparison.

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