Criteria for Selecting Access Management Performance Measures

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Abstract

An access management program requires state and local planners to work with land developers, elected officials, and the general public. For the program to be successful, all interested parties must understand its goals, and they must be able to quickly determine whether these goals are being met. A set of performance measures may help decision makers understand the effects of an access management program and enable them to evaluate, and thus improve, this program while it is underway.

For a performance measure to communicate the progress of a program effectively, it must meet four criteria: (1) be easily understood, (2) be feasible to implement, (3) be responsive to different alternatives, and (4) be under the control of the agency administering the program. Three candidate performance measures evaluated using these criteria are: (1) the average crash rate for a highway segment, (2) the average number of conflict points for a highway segment, and (3) the locality's inclusion of access management in its comprehensive plan.

No performance measure met all four criteria, but by applying these performance measures to three roadway segments in Virginia, it was possible to determine their strengths and weaknesses. To evaluate criterion one, a survey is being conducted to determine which performance measures are most easily understood. Therefore, only the remaining three criteria were evaluated for this paper. The average crash rate met the second criterion well, but fared less favorably for the third and fourth criteria. The number of conflict points performed worse for the second criteria, but better for the third and fourth. The locality's inclusion of access management performed the worst for all three criteria.

1.0 Introduction

Properties along arterial highways with high traffic volumes are prime locations for commercial development. Since development requires access, which in turn reduces arterial capacity, speed, and safety, access management programs have been implemented by many states. Although some property owners perceive a detrimental effect of access management, the benefit is not always evident. Accordingly, performance measures to evaluate access management programs are valuable tools for state transportation agencies. This paper addresses how to select the most productive performance measures for an access management program with an emphasis on Virginia's highway network and access management program.

2.0 Principles of Performance Measurement

Means to develop effective performance measures are discussed in the literature (Cambridge Systematics, Inc., 2006; Hranac and Petty, 2007; Keel, O'Brien, and Morrissey, 2006; Wye, 2002). Performance measures are used to assess the extent to which a program is achieving an intended goal (Wye, 2002) and progress achieved in meeting that goal (Cambridge Systematics, Inc., 2006). Accordingly, selection of an appropriate performance measure depends on a clear understanding of the goals of the program.

Four criteria used by many state transportation agencies to describe an effective performance measure are as follows (Cambridge Systematics, Inc., 2006):

1. Understandable by end users
2. Implementable with current resources
3. Responsive to different alternatives
4. Related to actions controlled by the implementing agency

The following sections discuss each criterion.

2.1 Understandable by end users

Performance measures should be transparent to the end user. Wye (2002) notes that "Stakeholders must be identified, and a specific communication strategy designed with them in mind" (Wye, 2002, p. 54). Performance measures must be easily understood, verifiable, and preferably based on observations rather than predictions (Hranac and Petty, 2007).

2.2 Implementable with current resources

The cost of collecting supporting data, performing appropriate calculations, and displaying the performance measure should be feasible with existing resources. The information gained from a performance measure should justify the cost associated with compiling the data used to calculate that measure (Keel, O'Brien, and Morrissey, 2006).

2.3 Responsive to different alternatives

Performance measures should be sensitive to the alternatives being considered. For example, vehicle operating cost is an approximate performance measure for assessing a one-mile resurfacing initiative because treatment alternatives (asphalt, concrete, etc.) will not indicate an observable change in the operating cost. A more appropriate metric is ride quality or pavement roughness.

Often direct measures are infeasible and intermediate results (outputs) or agency resources (inputs) may be used (Wye, 2002). Input and output measures may provide useful diagnostic tools for understanding changes in outcomes. For the resurfacing example, evaluating input measures (such as the number of full time maintenance staff available) and output measures (such as miles of roadway resurfaced per year) may assist in understanding outcome measures (such as vehicle operating cost).

2.4 Related to actions controlled by the implementing agency

Performance measures should relate to actions controlled by the transportation agency (Cambridge Systematics, Inc., 2006). For a state DOT, traffic injuries are illustrative. They are useful because they are partly based on design, maintenance, and operational practices of the state DOT. Yet they are not ideal because they are influenced by actions not controlled by the state DOT, such as the behavior of the driver.

3.0 Candidate Performance Measures

Based on the literature (Gluck, Levinson, and Stover, 1999; Transportation Research Board, 2003), there are three areas of an access management program where performance can be evaluated: outcomes, design features, and administrative procedures.

3.1 Candidate Outcome Measures

Outcome performance measures directly assess the progress towards an explicit goal of an access management program. For example, the *Code of Virginia* (§ 33.1-198.1) notes five goals of the access management program:

1. To reduce traffic congestion and impacts to the level of service of highways, leading to reduced fuel consumption and air pollution;
2. To enhance public safety by decreasing traffic crash rates;
3. To support economic development in the Commonwealth by promoting the efficient movement of people and goods;
4. To reduce the need for new highways and road widening by improving the performance of the existing systems of state highways; and
5. To preserve public investment in highways by maximizing their performance.

3.2 Candidate Design Measures

Outcome measures such as the average crash rate are affected by other phenomena besides access management. Therefore, it may be more productive to measure an intermediate result that is directly influenced by the transportation agency (Wye, 2002), which are design measures. Design characteristics that manage access for an arterial facility include the following (Gluck, Levinson, and Stover, 1999; Transportation Research Board, 2003):

- Conflict points
- Distance between traffic signals
- Distance between unsignalized access points
- Use of medians and two-way left turn lanes
- Use of dedicated left turn lanes
- Restrictions at median openings
- Use of frontage roads and supporting streets

3.3 Candidate Administrative Measures

Although design measures are directly influenced by a transportation agency, they are not temporally sensitive to actions taken by that agency. For example, a decrease in the distance between traffic signals may be the result of agency decisions made several years previously. Therefore, it may be productive to assess more immediate results in the form of administrative measures. The administrative actions required for an access management program to be successful are (1) cooperation between the various agencies responsible for access management decisions (Williams, 2004) and (2) existence of an access management strategy that explicitly considers future development along a corridor (Plazak, et al., 2004). For a given corridor, poorly managed access does not occur immediately but rather transpires gradually as land adjacent to the corridor develops. It is likely that access will not be managed unless there is a plan that is followed when additional access points are requested.

4.0 Three Proposed Performance Measures

Based on the literature and discussions with planners who are helping implement access management programs in Virginia, three performance measures are evaluated:

1. Outcome: Crash Rate
2. Design: Conflict Points per Mile
3. Administrative: Inclusion of Access Management in the Comprehensive Plan

Application of each candidate measure reveals a tradeoff among the four criteria. Although a perfect performance measure may not exist, some measures may be better than others and a methodology is needed to evaluate candidate performance. This section discusses how to score the three performance measures with regard to the four criteria: ease of understanding, feasibility of implementation, sensitivity to alternatives, and degree of control by the transportation agency.

4.1 Understandable by end users

To determine which measures are most easily understood, a survey is being conducted of the transportation professionals who would use such a metric. Users include local planners who influence land development, consultants who represent private landowners seeking to develop parcels, representatives of metropolitan planning organizations (MPOs) who address regional mobility concerns, and planning and engineering staff from the Virginia Department of Transportation (VDOT) who deliver or influence the state's access management program. A total of 443 surveys, individually addressed to respondents, have been distributed as follows: all counties (95), all independent cities (39), and select incorporated towns (42); planning district commission (PDC) and MPO employees (26); VDOT staff (25); and land development consulting firms (216).

The survey consists of 13 questions. Four assess the background of the potential respondent based on job title, employer, and experience in access management. Three questions ask the potential respondent to rank several performance measures, which are presented in three groups: outcome measures, design measures, and administrative measures. One question asks the potential respondent which set of measures (outcome, design, or administrative) are most useful. Three questions ask the potential respondent to rate the importance of various components of an access management program such as updating access standards or establishing interagency agreements for a specific corridor. (Survey results are being tabulated and not available for inclusion in this paper)

4.2 Implementable with current resources

In order to judge whether the implementation of a performance measure was feasible, the three measures were applied to three roadway segments across Virginia: US Route 29 in Prince William County, US Route 250 in Albemarle County, and VA Route 3 in Spotsylvania County, as shown in Figure 1.

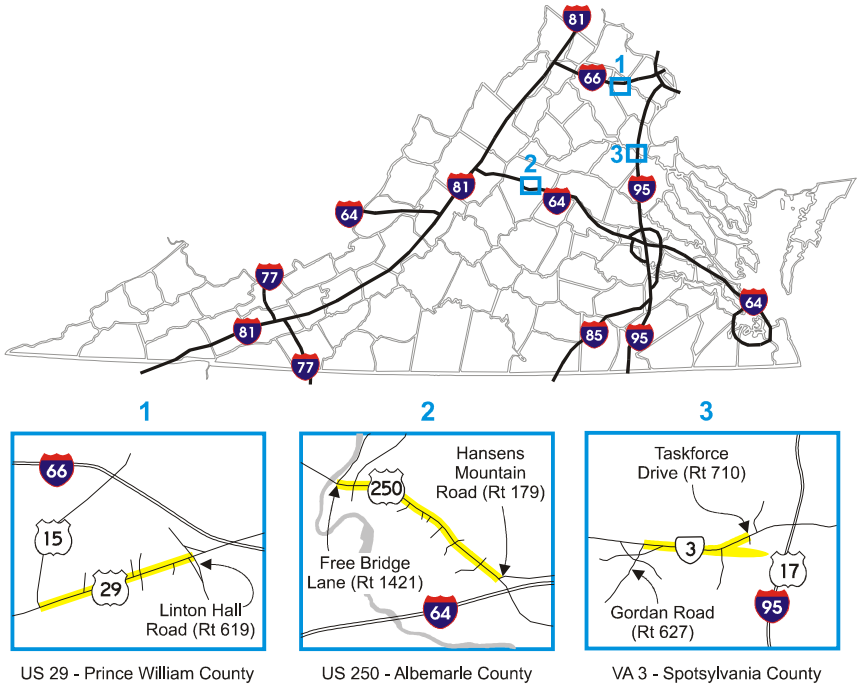


Figure 1. Location of highway segments for which candidate performance measures were applied

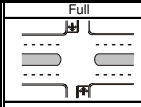
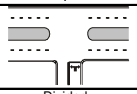
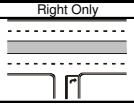
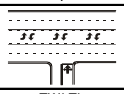
4.2.1 Crash Rate

VDOT's crash records database and VDOT's traffic count database provide the raw data which can be used to compute the number of crashes per vehicle miles traveled. Although these queries may be completed relatively quickly, there can be cases where, because of new construction, a location is not in the database and the crash is marked as unknown. Such a situation can be overcome through manually examining individual crash reports, which increases the data collection cost. For the roadways examined in this study, new construction caused many crashes to be marked with an unknown location. In Prince William and Spotsylvania Counties, the majority of these occurred within the highway segments in this study, but in Albemarle County, many of them did not. For calculations in this paper, all crashes with an unknown location were excluded.

4.2.2 Conflict Points per Mile

The number of conflict points per mile can be computed from aerial photographs (taken in 2002) and a roadway video database (created in 2001 when photographs were taken from a driver's perspective at 0.01-mile intervals along all Virginia state roadways.) To allow the number of conflict points to be tabulated quickly, a scorecard (see Figure 2) was developed allowing various types of intersections to be tallied. Each type of intersection is assigned a number of conflict points according to the *Access Management Manual* (Transportation Research Board, 2003). For example, a four-way intersection has 32 conflict points and a three-way intersection has 9 conflict points. (The scorecard facilitates computation of other measures such as the number of driveways and the number of signalized intersections.)

Access Management Data Collection Sheet

Highway Number		Locality		AADT	
Highway Name		Date		Area Type	
Starting Point		Evaluator			
Ending Point		Data Source			
Segment Length		Age of Data			
Type of Intersection	Full	T	Right Only	T	Other
Picture					
Median Type	Divided			TWLTL	
Signalized					
Unsignalized					
Conflict Points	32	9	2	9	
Totals Signalized					
Totals Unsignalized					

	Total Conflict Points	Notes
Signalized		
Unsignalized		
Signalized Per Mile		
Unsignalized Per Mile		
Total Per Mile		

Figure 2. Data collection sheet to evaluate conflict points per mile.

The scorecard shown in Figure 2 shows four types of intersections: a full intersection, a three-way intersection (T-intersection), a right in/right out (RIRO) intersection, and an intersection with a two-way left-turn lane. However, when other types of intersections are added, data collection is slower and requires on-site decisions as to the type of intersection. An aerial and video database may contain information that is more than five years old, and costly site visits may be required.

4.2.3 Inclusion of Access Management in the Comprehensive Plan

Local comprehensive plans are usually readily available on the Internet as was the case for the three localities described in this paper (Albemarle County, VA, 2005; Prince William County, VA, 2008; Spotsylvania County, VA, 2002). The transportation sections of the three plans reviewed are relatively short, assuring ease of review and comprehension. A worksheet (see Figure 3) assists in evaluating the extent to which a locality's comprehensive plan supports access management.

Comprehensive Plan Data Collection Sheet					
Locality Name			Highway Name		
Year of Comp. Plan			Highway Number		
Section of Plan			Evaluator		
Pages Reviewed					
Source of Plan					
General References to Access Management	Pages of References	Notes		Other comments	
Highway Specific References to Access Management	Pages of Reference	Highway Referenced	Notes		
Questions			Yes/No	Comments	
Are functional classifications mentioned?					
What is the road in question classified as?					
Does this agree with VDOT's classification?					

Figure 3: Data collection sheet to evaluate a locality's comprehensive plan

The absence of the term "access management," does not imply lack of support in the comprehensive plan. All three plans supported access management strategies without specifically labeling them as such. For example, in Albemarle County's comprehensive plan, "access management" is mentioned only in conjunction with US Route 29. However, three of the ten general design standards for roads directly support access management strategies (Albemarle County, VA, 2005). Thus, searching for the words "access management" would mask design standards as the tool used to implement an access management program.

4.3 Responsive to different alternatives

The performance measures developed to evaluate access management programs should vary for different alternatives. For the outcome and design performance measures, two alternatives are selected:

1. Alternative A: Full median with dedicated left turn lanes (US 29 and VA 3)
2. Alternative B: Partial median with two-way left turn lanes (US 250)

4.3.1 Crash Rate

Modifying a highway to change a two-way left-turn lane to a non-traversable median has been shown to produce a safer roadway. Gluck, Levinson, and Stover (1999) summarized numerous studies and found a mean reduction in accident rates of 27 percent.

However, this finding presumes that all other factors are held constant. When comparing two different highway segments, these factors will not be constant. For example, although US 250 had two-way left turn lanes whereas VA 3 had a nontraversible median, 2002 crash data showed that US 250 had a lower crash rate of 2.90 crashes per million VMT than VA 3 which had a crash rate of 5.00 per million VMT. Thus when comparing the crash rate on two different

segments, the performance measure analyst must consider the extent to which factors other than access management explain the difference in crash rate.

4.3.2 Conflict Points per Mile

The number of conflict points per mile can be altered by which of the two alternatives is selected. By changing a two-way left-turn lane into a median, the number of conflict points at every T-intersection would be reduced from nine to two. The number of conflict points per mile for each of the two alternatives is calculated as follows:

Alternative A (US 29):

$$\text{CP/mile}_A = \frac{\left(\begin{array}{l} (4\text{Full intersections})\left(\frac{32\text{ conflicts}}{\text{Intersection}}\right) + (9\text{ T - Intersections})\left(\frac{9\text{ conflicts}}{\text{Intersection}}\right) + \\ (21 RIRO\text{Intersections})\left(\frac{2\text{ conflicts}}{\text{Intersection}}\right) + 28\text{ other conflicts} \end{array} \right)}{3.0 miles} = 93$$

Alternative B (US 250):

$$\text{CP/mile}_B = \frac{\left(\begin{array}{l} (4\text{Full intersections})\left(\frac{32\text{ conflicts}}{\text{Intersection}}\right) + (3\text{ T - Intersections})\left(\frac{9\text{ conflicts}}{\text{Intersection}}\right) + \\ (12 RIRO\text{Intersections})\left(\frac{2\text{ conflicts}}{\text{Intersection}}\right) + (20 TWLTL\text{Intersections})\left(\frac{9\text{ conflicts}}{\text{Intersection}}\right) + 6\text{ other conflicts} \end{array} \right)}{1.7 miles} = 215$$

4.3.3 Inclusion of Access Management in the Comprehensive Plan

The inclusion of access management principles in a locality's comprehensive plan is a result of many factors. State transportation agencies have the ability to influence comprehensive plans, but their level of influence depends on their relationship with localities.

First, the state transportation agency must decide what communication strategy should be used with local governments. Many times, local governments do not understand the need for corridor management programs (Williams, 2004). The Urban Land Institute (Godschalk, et al., 1994) notes that mutual education is an often overlooked step of problem solving. For example, the segment of VA 3 reviewed for this paper is classified as a principal arterial by VDOT (Grimes, 2008), but Spotsylvania County classifies the highway as a minor arterial in its comprehensive plan (Spotsylvania County, VA, 2002). This discrepancy may be an indication of poor communication between VDOT and Spotsylvania County.

Second, a set of criteria must be established that will be used to make decisions. The criteria may be technical, political, or value-based (Godschalk, et al., 1994). Depending on how heavily one of these sets of criteria is favored, the final solution may change widely. For example, a technical solution may be based achieving a performance standard, a political

solution may be based on satisfying those in power, and a value-based solution may be based on preserving the character of the area (Godschalk, et al., 1994).

4.4 Related to actions controlled by the implementing agency

For a performance measure to be useful, changing the measure must be within the agency's purview. Each of the measures discussed can partially be influenced by the state as discussed in the following sections.

4.4.1 Crash Rate

Although it is generally acknowledged that access management can improve safety (Gluck, Levinson, and Stover, 1999; Transportation Research Board, 2003), other factors besides access management, such as signal timing, driver behavior, and intersection design, influence crash risk. For example, it has been shown that models that predict crash risk as a function of access management characteristics (such as number of signals per mile) may have an error (between predicted crashes and actual crashes) of between 27% and 29%, with the error resulting because of these other influences (Miller et al., 2001).

4.4.2 Conflict Points per Mile

The number of conflict points per mile is within the control of the state to a greater extent than are the other two candidate performance measures. For example, the *Code of Virginia* § 33.1-198 (Effective July 1, 2008) requires that commercial entrances comply with "the Commonwealth Transportation Commissioner's access management standards for the location, spacing, and design of entrances." The *Code* also allows the Commonwealth Transportation Commissioner to require a new entrance to be shared with adjacent property owners if possible. Through these regulations, VDOT has a high level of control over the number of conflict points on a segment of roadway.

4.4.3 Importance of Access Management in the Local Comprehensive Plan

The *Code of Virginia* §15.2-2222.1 requires localities to submit their comprehensive plans to VDOT to be reviewed. After receiving the plan, VDOT may request a meeting with the locality to discuss the plan. The *Code* calls for these discussions to continue "as long as the participants deem them useful." Although comprehensive plans are reviewed by VDOT, they are still a product of the individual localities, giving VDOT less control over the inclusion of access management in the plan.

4.5 Summary and Conclusions

The application of the three candidate performance measures along with the information in the literature allows the three measures to be compared in Table 1. As seen in the table, none of the three measures fully satisfy all of the criteria when ranked from High (Excellent) to Low (Poor). Although the data are readily available to compute it, crash rate is less within the control of a state transportation agency than is conflict points per mile. The inclusion of access

management in comprehensive plans scored the lowest with the data harder to analyze and little relationship between a transportation agency's actions and comprehensive plans' contents. Other administrative measures may score higher. Applying the candidate performance measures suggests three conclusions:

1. *No performance measure is perfect when evaluated using all four criteria considered in this paper.* Generally, measures that have a close relationship to the end goals of an access management program will not be within the control of a state transportation agency. A test application of candidate performance measures can help determine which ones satisfy all four criteria to the highest extent.
2. *Different measures have different strengths.* Depending on who is using the performance measure, the relative importance of the four criteria may be different.
3. *A test application of the candidate performance measure is important.* It would be expected that an administrative measure would be more within the control of VDOT. In this case, the inclusion of access management in a comprehensive plan is more under the control of the local authorities than of VDOT.

Table 1. Summary of test application

Performance Measure	Data Availability	Variance Based on Alternatives	Virginia Department of Transportation's Ability to Control
Crash Rate	High	Medium	Medium-Low
	Depends on level of detail desired. Simply obtaining the crash rate requires little resources because the information is already in a database. If a more detailed breakdown is required, more time will be required.	Research has shown that changing a two way left turn lane to a non-traversable median may reduce crashes by 27% (Gluck, Levinson, and Stover, 1999)	VDOT can implement changes in the roadway which will affect the crash rate, but many other factors also affect this value.
Conflict Points per Mile	Medium-High	High	Medium
	These data can be quickly determined by looking at aerial photographs. The accuracy of the information will affect the effort required to collect the data. Quick data collection may miss restrictions such as "no left turns."	Different roadway designs produce significantly different numbers of conflict points. For example, closing a median opening will reduce the number of conflict points from nine to two at a T-intersection.	VDOT can regulate the number of conflict points, but property owners still have a right to access the highway network.
Inclusion of Access Management in Comprehensive Plan	Low	Unknown	Low
	To compute this measure, the comprehensive plan must be read by someone who has some experience reading comprehensive plans.	Although all three plans placed a different emphasis on the importance of access management, more research is needed to determine how these plans were developed.	Since comprehensive plans are developed by localities, VDOT has less ability to control their contents. Although plans are reviewed by VDOT, the final decision regarding the contents of the plan rests with the locality.

High = Excellent, Medium = Good, Low = Poor.

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