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16. Abstract

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In this project, a general methodology was developed and applied to determine the role played by the Hampton Roads STC in regional systems operations in Virginia. A six-part framework for evaluating performance measures was developed. The findings of the study were generalized to the greatest extent possible to be applicable to other STCs in Virginia.

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FINAL REPORT

THE ROLE OF SMART TRAFFIC CENTERS IN REGIONAL SYSTEM OPERATIONS: A HAMPTON ROADS CASE STUDY

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INTRODUCTION

Smart traffic centers (STCs) play an integral role in the system operations and management of a regional transportation network. In this context, *system operations and management* means any function or activity that manipulates the highway system or network capacity in *real time* and/or provides information to travelers about the safety, capacity, or flow of the highway system.[1]

Today, there are three major metropolitan STCs in Virginia, one each in Northern Virginia, Richmond, and Hampton Roads. Six other districts of the Virginia Department of Transportation (VDOT) maintain an STC or are developing some type of intelligent transportation systems (ITS) functions. The role of an STC in regional system operations varies according to the needs of the area in which it is located. Although the STCs share a core group of common functions, such as incident detection and clearance, they also perform unique functions, based on their geographic location, surrounding populations, and local issues.

Currently, there is a need to define performance measures for STCs within the context of regional systems operations. Such performance measures, if established, would enable an STC to determine how well it is functioning in terms of the region's transportation network and identify areas where the efficiency of its operations could be improved. Without proper measures of performance, it is difficult to determine if changes or additional resources could be employed to improve STC operations.

PURPOSE AND SCOPE

The purpose of this study was to define the role of STCs in regional systems operations and to help identify performance measures for monitoring the performance of STCs within this domain. The Hampton Roads region—home to one of Virginia's most mature and unique transportation systems—was used as a case study to explore the region's functional makeup and

appropriate performance measures for these functions. The findings were generalized to the greatest extent possible to be applicable to other STCs.

The recommended framework for developing the measures of performance established in this research project will assist transportation engineers in documenting the benefits of the investment made in STCs. Monitoring performance in both a quantitative and a qualitative fashion will allow STC operators to identify areas where improvements can be made or resources need to be adjusted. The findings of this study might thus provide a means to justify expansion, upgrades, and enhancements for individual STCs. By defining the role of an STC within the region, this project will support more streamlined systems operations and more effective STC operations.

METHODS

An investigation into the role of STCs in regional system operations performance was accomplished through conducting five tasks:

1. *Literature Review.* The literature review focused on the topical areas of system operations, traffic management centers, and performance measurement in transportation. Information was gathered from the Internet, technical journals, contacts at state DOTs, individual traffic management centers (TMCs), and university research centers.

2. *TMC Survey.* A national survey of individuals identified as managers of 80 TMCs, a more generic name for STCs, was conducted to determine the state-of-the-art practices and techniques that are used nationwide. The survey questions and titles of the respondents are given in the Appendix. The survey was conduct using the Zoomerang Internet survey system.

3. *Analysis of Hampton Roads System.* The Hampton Roads highway system was defined in terms of its functions, goals, challenges, stakeholders, and resources. This phase of the study consisted of conducting site visits to interview key personnel at those state and local agencies associated with systems operations in the region and reviewing related published reports. By determining the specific functions in which the Hampton Roads STC (HRSTC) is involved, its role within the domain of regional systems operations was defined.

4. *Development of Framework for Evaluating Performance Measures.* A general framework for evaluating performance measures was developed and then applied in an example. A large "library" of performance measures was compiled through the literature review, survey, and site visits. This list was pared down with the help of key decision-support criteria. The determination of desirable performance measure attributes led to the establishment of these criteria.

5. *Development of Recommended Set of Performance Measures.* A set of performance measures for the key HRSTC functions was produced, and these metrics were evaluated for possible use by HRSTC. To the extent possible, the recommendations were made to be applicable to all Virginia STCs.

RESULTS AND DISCUSSION

Literature Review

System Operations

The transportation industry is in the process of a momentous shift in thinking, as departments of transportation (DOTs) are forced to contend with less open land and tighter budgets. Instead of building new capacity, DOTs are seeking to maximize the efficiency of the current transportation system, essentially "taking back" the capacity.[2] For example, instead of adding new lanes to a multi-lane highway to reduce congestion, a DOT might accomplish the same goal by using variable message signs (VMS), ramp metering, traffic signal optimization, and safety service patrols.

The term *system operations and management* is used to describe an organization driven by two bedrock objectives: to provide the service the customer wants and to maximize the efficiency of the existing network infrastructure. Sometimes these activities may already take place among different staff and teams, who operate with largely independent objectives, resources, and performance. This fragmented, or "stove-piped," approach should be phased out in favor of a formally integrated program. This integrated approach relies on common policies and performance data, as well as "continuous day-to-day cooperation" and "information-sharing."[2]

Recognizing the importance of this new transportation paradigm, VDOT recently overhauled its corporate structure. Now, a separate "System Operations" directorate is charged with "creating new focus, direction, and measurement for improving travel throughout Virginia [including] alleviating congestion at traffic choke points, developing innovative ways to manage highway incidents, and employing Smart Travel and traveler information systems."[3] Present applications of this strategy in Virginia include increased use of "near-real-time" performance data from instrumented highway sections and advanced traffic signals. In addition, technologies such as VMS and the *511 Virginia* telephone system are expanding to serve the traveling public further.

Region-wide collaboration among federal, state, and local officials is crucial to this systems approach to operations. It is also important for agencies involved in a regional alliance to maintain a solid perspective on the direction their region is heading. Often, the daily "imperatives" gain the most immediate attention, yet it is also essential that the agencies understand the "big picture" goals and objectives that will require longer periods of time to accomplish.

Benefits to the traveling public from a regional partnership can be numerous. Primarily, traveler delay can be reduced while traveler safety and overall customer satisfaction are increased. The impact of construction activities and special events can also be mitigated. Further, a consistent regional message leads to increased public awareness and understanding of transportation programs. Perhaps most important, regional collaboration can reduce resource redundancy and result in more efficient expenditure of tax revenues.

Performance Measures

Performance measurement is a key management technique used by leaders throughout the world to improve the operation of their organizations. Transportation performance measures can generally be lumped into three categories: input, output, and outcome. Input measures reflect the resources used at the outset of a program or process, and output measures signal what was bought or built using the invested resources.

Under the "system operations" umbrella, outcome measures are often viewed as the most desirable form of performance measurement. Outcome measures seek to capture information associated with the benefits and costs of the system from the perspectives of all interests of a particular system or program. For example, an "output" measure might be that a state DOT built 10 new miles of roadway during the last year. The "outcomes" of this improvement might be a reduction in travel times between two areas and an increased customer approval rating.

The Federal Highway Administration's *Freeway Management and Operations Handbook* states that the performance evaluation process is iterative and "allows practitioners to assess the effectiveness of their efforts, to identify areas for improvement, to justify these improvements, to demonstrate the benefits provided by the program, and to support requests for additional resources."[4] When linked to investment and resource allocation decisions, performance measurement results in better accountability, efficiency, effectiveness, communications, and clarity.

Another advantage of a performance-monitoring program is that it enables TMCs to negotiate performance-based contracts with private-sector companies. Structuring a performance-based contract allows the TMC to define the acceptable level of service to be provided by the contractor and permits it to pay the contractor based on how well the service is performed. Since TMCs operate in a real-time operations environment, performance measures for the operation of a TMC should reflect changes within a "real-time" context, and, once established, they should be in place long enough to provide consistent guidance in terms of improvements and monitoring to determine whether the objectives are being met.[4] Trends can be determined only through a consistent performance measurement approach. Further, it is essential to measure both *before* and *after* projects. Many states—including Virginia and Minnesota—now use a "dashboard" to display their success in delivering projects "on time and on budget." However, fewer states use similarly effective measures to show the outcomes of these projects.

It is important to limit performance measurement to a manageable number of measures of effectiveness. A properly "balanced" set of measures includes input, output, and outcome

measures. Existing data sources should be used to the extent possible. Ideally, "data availability" will be balanced with "analytic rigor."[5]

The most important question for a system operations–oriented agency to address is: "Who are the customers and what are their expectations?"[6] The goals of a system are aligned with the prevailing customer concerns, and so should be performance measures. According to Meyer, there are seven measures that "seem to be most important for system users."[6] These measures, or factors for which measures should be determined, provide a strong starting point for a customer-oriented agency looking for the best performance measures and are listed in Table 1.

Table 1. System Factors Associated with Performance[6]

1	System reliability
2	Reasonable travel time (or speed)
3	Safety
4	Average delay
5	Traveler costs
6	Physical condition of the transportation system
7	Customer satisfaction measures

Survey Results

Twenty-eight agencies (of the 80 originally contacted) responded to the survey. The survey respondents and responses are given in the Appendix.[7]

The responses show that TMCs largely rely on "in-house" employees. When contract personnel are used, it is generally in the areas of software development and information technology (IT) capacities. Because of the proprietary nature of most software packages, as well as the rate at which new versions of programs are developed and introduced, it is understandable why many TMCs find it desirable to contract out some IT functions.

The two most commonly used ITS functions among the survey respondents were closed-circuit television (CCTV) cameras and VMS. Many other ITS technologies are also used throughout the nation; traffic signal coordination and ramp metering are employed at about one-third of the TMCs surveyed.

Two primary methods used to disseminate traveler information are websites and highway advisory radio (HAR). Every survey respondent indicated that his or her TMC had a website for traveler information. Most of these portals include CCTV images; work zone announcements and incident alerts are other key data included on many sites.

Other findings from the survey include:

- Of the responding agencies, 83 percent do not have consistent benchmarks for performance measures.

- Although about 90 percent of TMCs archive traffic data, very few calculate and publish regular performance measures using these data.

- Of the TMCs that do develop performance measures, 75 percent are used for "system-wide monitoring," with the rest being used essentially in house.

- Only 21 percent of the respondents publish periodic evaluation reports.

- The most common performance measures used in these reports include benefit-cost analysis, incident delay, travel time, crash and fatality reduction, and website hits.

Hampton Roads System

Using the National ITS Architecture, VDOT developed its own ITS Architecture for Virginia. The VDOT ITS Architecture provides the foundation from which the system operations functions for a particular geographical region can be derived. In this study, system operations functions for the Hampton Roads region were derived from the statewide architecture. The *Smart Travel Implementation Framework* (STIF) describes the VDOT ITS Architecture,[8] which is broken down into six user service bundles:

1. System Management
2. Electronic Payment Systems
3. Emergency Management
4. Personal Travel Services
5. Commercial Vehicle Operations
6. Advanced Vehicle Safety Systems.

Through the STIF, VDOT delegated the responsibilities to set policy for, guide, and deliver the various user services to particular stakeholders. The primary system functions that involve the HRSTC occur at the regional/corridor level or the district/local level. Some of the services are more global, statewide efforts handled by VDOT's Central Office or, in some cases, directed nationally by the U.S. DOT. These responsibilities were not in the scope of this study, however. Table 2 shows the different user service bundles, user services, and functions established by the STIF. The table also shows which functions are applicable to system operations and which functions are of primary concern to the HRSTC.

As shown in Table 2, the HRSTC is principally committed to operating within three of the six functional areas ("bundles") established in the STIF. These clusters include system management, emergency management, and personal travel services. Two other functional areas can be considered part of regional systems operations: electronic payment systems and commercial vehicle operations. The HRSTC has a secondary part in these functions. The role of the HRSTC within the larger domain of the region is depicted in Figure 1.

Table 2. Mapping of STIF to Systems Operations Functions and HRSTC

VDOT Smart Travel Implementation Framework User Services and Functions	Current Systems Operations Function	Current HRSTC Primary Function
SYSTEM MANAGEMENT		
Traffic Management	X	X
Incident Management	X	X
Travel Demand Management	X	X
VDOT Operations Management	X	
Archived Data Function	X	X
Regulatory Functions	X	
Public Transit Management	X	
ELECTRONIC PAYMENT SYSTEMS		
Electronic Payment Services	X	
EMERGENCY MANAGEMENT		
Emergency Notification and Security	X	X
Emergency Vehicle Management	X	X
Disaster Response and Evacuation	X	X
PERSONAL TRAVEL SERVICES		
Pre-trip Traveler Information	X	X
En-route Traveler Information	X	X
Route Guidance	X	X
Traveler Services Information	X	X
COMMERCIAL VEHICLE OPERATIONS		
Electronic Clearance	X	
Intermodal Connections	X	
Administrative Processes	X	
Automated Roadside Safety Inspection	X	
On-board Safety and Security Monitoring	X	
Hazardous Materials Security and Incident Response	X	
Freight Mobility	X	
ADVANCED VEHICLE SAFETY SYSTEMS		
Intelligent Vehicle Initiative—Research		

Performance Measurement Framework

The basic framework for identifying performance measures consists of six steps (see Figure 2). The process is described here, and an application is subsequently shown.

1. *Identify the function that needs to be measured.* The function should be clearly defined in terms of resources, procedures, and objectives.

2. *Collect a "library" of possible measures.* This is best done by applying past experiences, contacting other people facing similar circumstances, and reviewing pertinent industry literature. The measures collected should include all applicable functional areas.

3. *Determine the criteria used to differentiate between the measures.* These criteria should include important factors and desired characteristics that would ideally be captured within the performance measure(s).

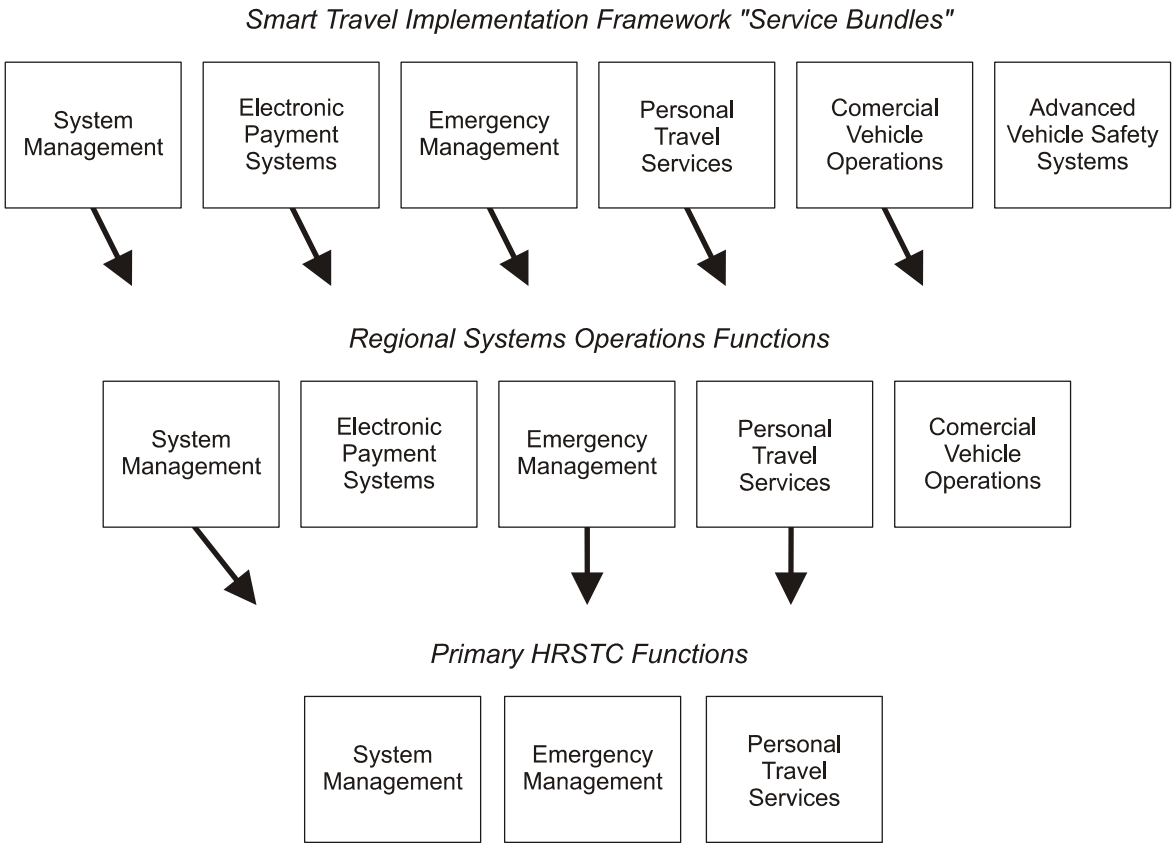

Figure 1. HRSTC Role in Regional System Operations

4. *Apply the criteria established in Step 3 to the library of all possible measures, and revise the original list.* Some measures will be discarded in this step, and the remaining measures will be investigated further to ascertain the feasibility of their use.

5. *Test the proposed measures for fitness.* If available, actual performance data should be used for validation. Sometimes this is not possible, however. In these cases, validation might involve determining the cost required to use particular measures or qualitatively examining each measure to determine its usefulness and suitability.

6. *Complete the list of performance measures.* The resulting list includes metrics that best suit performance measurement for a particular STC function. The framework can be reapplied to determine applicable performance measures for other STC functions.

If no suitable performance measures are found using this process, new performance measures may need to be uncovered. Deriving new performance measures could provide the basis for new research studies. It could also be merely a matter of STC managers, operators, and other knowledgeable parties putting their heads together to brainstorm new measures. Once an untested measure has been defined, the performance measure framework can be re-applied, starting from Step 3.

Due to the dynamic nature of transportation and ITS systems, the framework should be revisited periodically. One such occasion is when decision criteria change. For instance, a shifting political landscape might raise new "hot-button" issues that demand attention. Another reason for re-iteration of the model is the development of promising new performance measures. Agencies all over the nation (and the world) are trying to determine how best to implement performance measurement in their systems. If a new measure is developed that seems to work, it may be worth consideration within the framework. Other reasons to revisit the six-step model include the arrival of new, unmeasured STC functions and the growth of types or sources of performance data.

For the purposes of this project, it was impractical to apply the six-step model to an exhaustive level of detail. The framework is instead presented so that STC managers and operators may use it as a guide in their own decision-making processes. STC (or TMC) practitioners are equipped with the required background of practical knowledge and experience to apply the model to their individual situations. These individuals may need performance measures to help with day-to-day operations, or their needs might be oriented more to the long term.

The following section contains an illustration of how the framework may be used to select performance measures, using the HRSTC as an example.

Hampton Roads Case Study: An Example Application

Step 1: Identify STC Function to Be Measured

The specific functions in which the HRSTC is most heavily involved have been shown to fall into three categories: system management, emergency management, and personal travel services. There are 11 primary functions within the general categories (see Table 2 for a function mapping).

Step 2: Collect Library of Performance Measures

An Excel spreadsheet containing a large sample of performance measures currently in use by transportation agencies around the nation was compiled. The spreadsheet may be accessed at http://www.virginiadot.org/vtrc/main/online_reports/pdf/list-2.xls. The measures are defined to the extent possible to eliminate any ambiguity of their intended use and classified according to user service and function. In addition to providing a collection of measures for this case study, the spreadsheet provides a library of possible measures for future applications and can be expanded or contracted as experience is gained.

Step 3: Determine Specific Selection Criteria

To help rate and decide between prospective measures of effectiveness, a set of appropriate criteria must first be established. Performance guidelines may be obtained through practical experience and peer-to-peer sharing or during the literature review. A sample set of general criteria that can be used to evaluate the various performance measures under consideration is presented here. The components that comprise each criterion are also described.

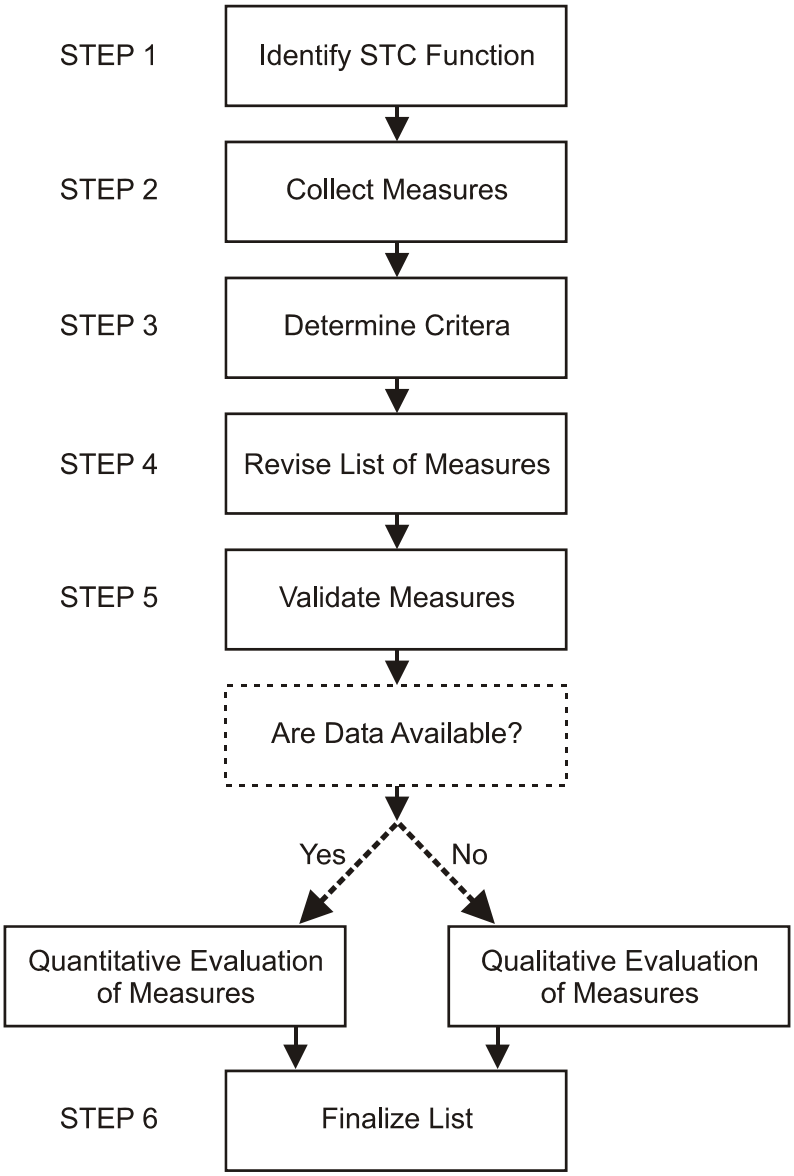

Figure 2. Six-Step Framework for Establishing STC Performance Measures

These criteria and their sub-components will be applied to each potential performance measure to help gauge the worthiness of the measure. These criteria are intended as a decision-support tool to show the relative strengths and weaknesses of the various measures; they are not intended to serve as the sole basis for deciding to use or discard a particular performance measure.

Applicability

Applicability is a broad term intended to capture a number of desired traits. The measure should pertain to the specific system or practices in question. It is best if the measure reflects the performance of the system operators, rather than something largely outside of their control. Although not a definite requirement, it is useful if the measure has been widely used or adopted,

or at least proven to work well. Some of the other desired qualities that would make a measure more applicable to systems operation are given in Table 3.

Table 3. Desirable Characteristics for System Operations Performance Measures[9]

Proactive
Customer-focused
System-oriented
24/7
Performance-based
Real-time

Clarity

This criterion takes into account the clearness and meaning of the results. Clarity is a very important consideration due to the importance of properly and clearly communicating performance. If the target audience (whether that be the general public, VDOT management, lawmakers, etc.) is unable to understand the measure, the metric is ineffective. Therefore, it is best if technical language can be avoided and the measure can be worded in fairly simple terms.

Clarity also takes into account the ease with which the measure is computed, presented, and interpreted. Some measures may be too hard to calculate, and the benefit derived from reporting the measure does not warrant the cost of deriving it. Another consideration is whether it is consistent with past performance monitoring. When the same measure is used over a significant period of time, trends in performance can be seen, and such information is very valuable.

Precision

Precision concerns the assumptions inherent in the measure and how much of an impact they make; whether data are available at the necessary level of detail; the consistency of the results (over time, between facilities, etc.); and how often results are updated or refreshed (i.e., is the reporting cycle monthly, quarterly, annual, etc.). *Precision* also includes margins of error or tolerance levels.

Flexibility

One of the problems some performance measures have is they become obsolete as new technology is introduced or new problems surface. Flexible measures should—to the extent possible—be adaptable to accommodate future problems and technologies. That way, the measure will be relevant over time and can be used to determine trends. Other considerations for flexibility include how the measure can be applied at various levels of an organizational hierarchy (strategic, operational, etc.) and whether the measure is multimodal or applicable only to automobiles.

Step 4: Revise List of Measures

The list of all possible measures is reduced by evaluating prospective measures based on the individual criteria established in the previous step. Tables 4 through 6 show examples of a decision matrix, which is an effective format for revising the list of measures by applying the criteria. In the example, six candidate measures are chosen for each STC function. A rating of "HIGH," "Fair," or "low" is assigned to each performance measure/criterion combination. Alternatively, numerical values can be used to calculate an overall score for each potential performance measure.

System Management

Table 4 provides the evaluation of the system management candidate measures.

Table 4. Evaluation of System Management Candidate Measures

Service Bundle: System Management					
	Criteria				
Measure	**Applicability**	**Clarity**	**Precision**	**Flexibility**	**Decision**
TRAFFIC MANAGEMENT					
Number of STCs integrated with HRSTC	HIGH	Fair	HIGH	low	USE
Travel time	Fair	HIGH	low	Fair	discard
% required HRSTC/FIRT positions filled	HIGH	HIGH	Fair	Fair	USE
% system congested (i.e., LOS E or F)	low	Fair	low	Fair	discard
Travel time reliability	HIGH	Fair	Fair	HIGH	USE
% customer satisfaction with HRSTC	HIGH	HIGH	HIGH	HIGH	USE
INCIDENT MANAGEMENT					
Average incident clearance time	HIGH	HIGH	Fair	HIGH	USE
% customer satisfaction with FIRT	HIGH	HIGH	HIGH	HIGH	USE
Average incident response time	HIGH	HIGH	Fair	HIGH	USE
FIRT coverage (lane-miles, vehicle-hours)	HIGH	HIGH	HIGH	Fair	USE
% ITS devices operational	HIGH	HIGH	Fair	Fair	USE
% detections, by type of detection	HIGH	HIGH	Fair	Fair	USE
TRAVEL DEMAND MANAGEMENT					
HOV lane volume	HIGH	Fair	low	HIGH	USE
HOV lane average speed versus regular lanes	HIGH	Fair	low	Fair	USE
Number of transit stops	low	HIGH	HIGH	low	discard
% population within 0.25 mi of transit stop	low	low	low	Fair	discard
HOV lane hours of operation	Fair	HIGH	HIGH	Fair	USE
Time to reverse direction of RHOV roadway	HIGH	Fair	HIGH	Fair	USE
ARCHIVED DATA FUNCTION					
% data that are "complete" or "usable"	HIGH	Fair	Fair	Fair	USE
Number of data collection stations	Fair	HIGH	HIGH	Fair	USE
Frequency or repeat time of data	Fair	low	HIGH	Fair	discard
Number of ADMS database queries	low	Fair	Fair	Fair	discard
Number of STCs integrated with ADMS	HIGH	Fair	HIGH	low	USE
Number of "new" data elements	Fair	Fair	HIGH	Fair	discard

Emergency Management

Table 5 provides the evaluation of the emergency management candidate measures.

Table 5. Evaluation of Emergency Management Candidate Measures

Service Bundle: EMERGENCY MANAGEMENT					
Measure	**Criteria**				**Decision**
	Applicability	**Clarity**	**Precision**	**Flexibility**	
EMERGENCY NOTIFICATION AND SECURITY					
Number of agencies integrated with HRSTC	HIGH	Fair	HIGH	low	USE
Freq. of emergency communication tests	HIGH	Fair	Fair	Fair	USE
% ITS devices operational	HIGH	HIGH	Fair	Fair	USE
Time since last response plan meeting	Fair	HIGH	Fair	low	discard
Customer awareness of HRSTC services	HIGH	Fair	Fair	HIGH	USE
% accidents with secondary incidents	Fair	low	low	Fair	discard
EMERGENCY VEHICLE MANAGEMENT					
Average incident response time	HIGH	HIGH	Fair	HIGH	USE
Average incident clearance time	HIGH	HIGG	Fair	HIGH	USE
% customer satisfaction with FIRT/HRSTC	HIGH	HIGH	HIGH	HIGH	USE
Number of lanes blocked/ incident duration	low	low	Fair	Fair	discard
Number of on-call injuries to FIRT drivers	HIGH	HIGH	HIGH	Fair	USE
% incidents/ appropriate vehicle dispatch	Fair	Fair	low	Fair	discard
DISASTER RESPONSE AND EVACUATION					
Time since last response plan meeting	Fair	HIGH	Fair	low	USE
Customer awareness of evacuation route	HIGH	HIGH	Fair	HIGH	USE
% ITS devices operational	HIGH	HIGH	Fair	Fair	USE
Number of abandoned vehicles	low	Fair	HIGH	Fair	discard
Evacuation clearance time	HIGH	Fair	Fair	Fair	USE
Traffic flow rate, storm events vs. normal	Fair	Fair	low	low	discard

Personal Travel Services

Table 6 provides the evaluation of the personal travel services candidate measures.

Step 5: Validate Proposed Measures

After the application of Step 4, the list of potential measures will be narrowed down significantly. With a manageable number of remaining metrics to assess, the proposed measures must be validated. Testing the validity of a performance measure involves calculating the measure, or determining the relative cost and benefit that could be expected from using the measure. Data supporting a performance measure may or may not be readily accessible. However, just because data are unavailable does not mean the measure is invalid. Instead, new data sources may have to be developed or tapped to facilitate using the desired measure.

Table 6. Evaluation of Personal Travel Services Candidate Measures

Service Bundle: Personal Travel Services					
Measure	**Criteria**				**Decision**
	Applicability	**Clarity**	**Precision**	**Flexibility**	
PRE-TRIP TRAVELER INFORMATION					
Number of 511 Virginia website hits	Fair	HIGH	HIGH	Fair	USE
HAR coverage area	HIGH	HIGH	HIGH	Fair	USE
Number of subscribed CCTV tour users	low	HIGH	Fair	low	discard
% work zones announced ahead of time	HIGH	Fair	Fair	HIGH	USE
% special events announced ahead of time	HIGH	Fair	Fair	HIGH	USE
Number of calls to 511 Virginia	Fair	HIGH	HIGH	Fair	USE
EN-ROUTE TRAVELER INFORMATION					
Average VMS refresh time	HIGH	HIGH	low	HIGH	USE
% accidents with secondary incidents	Fair	low	low	Fair	discard
Average HAR refresh time	HIGH	HIGH	low	HIGH	USE
Number of subscribed wireless info users	low	HIGH	Fair	low	discard
% ITS devices operational	HIGH	HIGH	Fair	Fair	USE
Number of "new" ITS devices	low	Fair	HIGH	Fair	discard
ROUTE GUIDANCE					
VMS message delay after incident	HIGH	Fair	Fair	HIGH	USE
% work zones with VMS messages	HIGH	HIGH	HIGH	HIGH	USE
Average VMS refresh time	HIGH	HIGH	low	HIGH	USE
Average HAR refresh time	HIGH	HIGH	low	HIGH	USE
% ITS devices operational	HIGH	HIGH	Fair	Fair	USE
Number of "new" ITS devices	low	Fair	HIGH	Fair	discard
TRAVELER SERVICES INFORMATION					
Number of 511 Virginia website hits	Fair	HIGH	HIGH	Fair	USE
% CCTV cameras that are media accessible	Fair	Fair	Fair	Fair	discard
HAR coverage area	HIGH	HIGH	HIGH	Fair	USE
Number of website enhancements	low	low	Fair	Fair	discard
Number of calls to 511 Virginia	Fair	HIGH	HIGH	Fair	USE
511 Virginia coverage area	HIGH	HIGH	HIGH	Fair	USE

The primary sources of data for use by STCs include the following:

- ITS data that are automatically collected and archived in the Archived Data Management System (ADMS), HRSTC incident database, or Virginia State Police Computer-Aided Dispatch (CAD) database
- customer feedback cards distributed by the Freeway Incident Response Teams (FIRT)
- data from *511 Virginia* and other providers of traveler information
- other customer surveys or evaluations.

Following are examples under each bundle of services of how data can be used to demonstrate the feasibility of using a particular measure.

System Management

There is a typically a correlation between proper STC staffing levels and STC performance, as evidenced by the *Hampton Roads Freeway Incident Response Team (FIRT) Impact Study*.[10] This is HRSTC's first line of defense for incident management. The teams are safety service patrollers who assist with accidents, stalled and abandoned vehicles, and other highway and motorist emergencies.

In this case, a performance measure showing the actual number of on-duty employees versus the desired and/or required staffing levels is beneficial—for use not only within the STC but also when new budget and resource allocations are negotiated.

Another candidate measure under the umbrella of system management is percentage of incident detections, grouped by the source of their initial detection. By determining the percentage of incidents that are discovered by each method used at HRSTC (FIRT, CCTV cameras, motorist telephone calls, etc.), STC operators could determine the cost-effectiveness of each type of service. Then, resource allotments could be redistributed "proactively" among the various methods of detection to facilitate the incident management function. This measure clearly fits the system operations mission of VDOT and HRSTC and is illustrated in Table 7.

An example of a potential performance measure for travel demand management carried over from Step 4 is the difference in vehicle speeds between high-occupancy vehicle (HOV) and regular traffic lanes. A graphical representation of this speed difference over a recent 1-month period can be seen in Figures 3 and 4. Figure 3 shows that the regular-lane travel speeds on I-64 eastbound range from approximately 30 mph to 55 mph, with two sections of the road showing speeds in excess of 55 mph. In contrast, Figure 4 depicts that average speeds on the reversible HOV lanes (RHOV) roadway during the same time frame are all above 55 mph, ranging as high as 70 mph. Tracking and comparing such values allow for quantification of the effectiveness of HOV lanes, an important element of travel demand management.

Table 7. Percentage of HRSTC Incident Detections by Type of Detection Source[11]

	July 2002		July 2003	
Detection Source	**Incidents**	**%**	**Incidents**	**%**
FIRT	3,257	86.9	1,490	83.6
Virginia State Police Radio	172	4.6	90	5.0
CCRV Camera	104	2.8	127	7.1
Phone Call	139	3.7	35	2.0
Other	74	2.0	41	2.3
Total Incidents	3,746	100.0	1,783	100.0

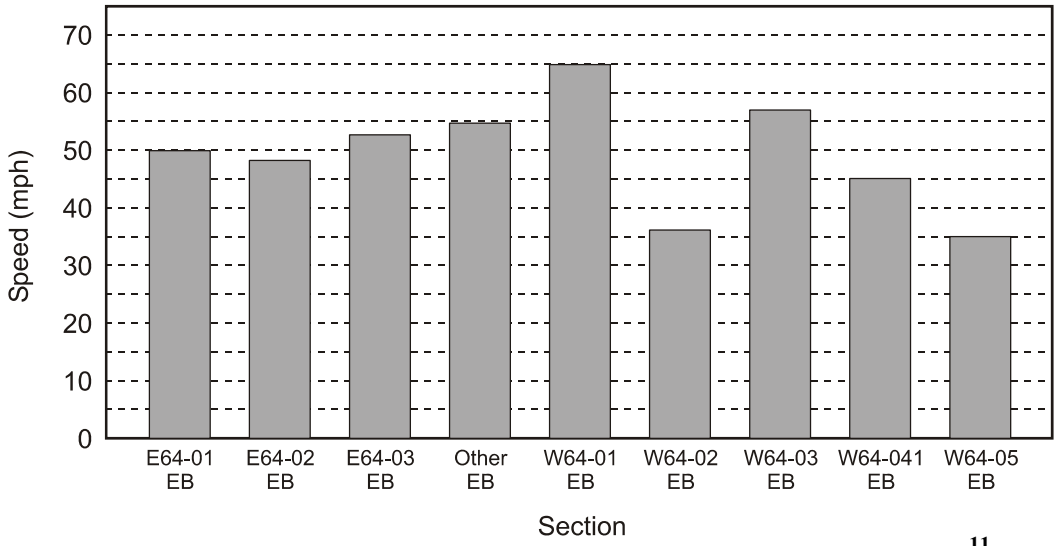

Figure 3. Average Speeds on I-64 Eastbound During Peak Hours in April 2005[11]

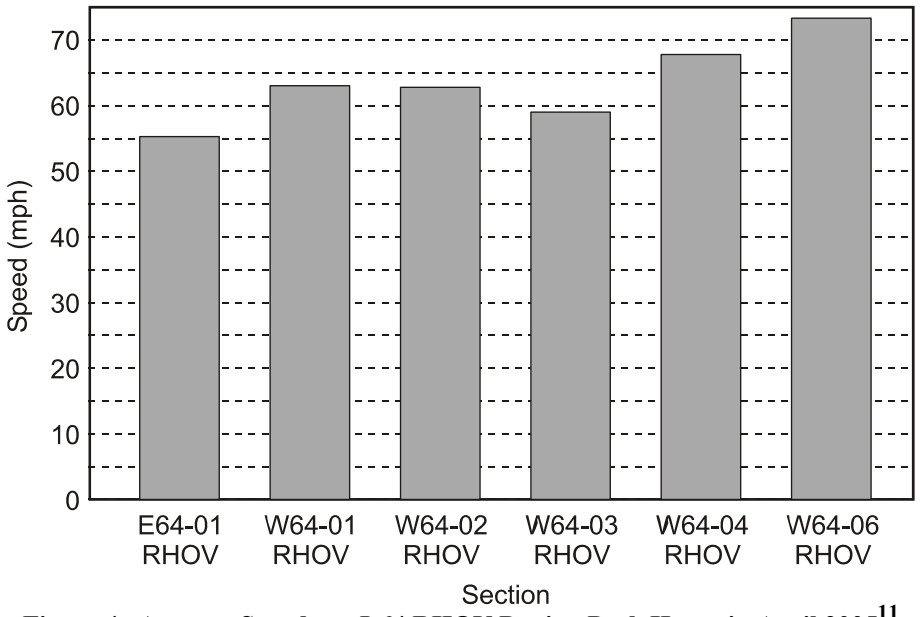

Figure 4. Average Speeds on I-64 RHOV During Peak Hours in April 2005[11]

Emergency Management

Customer-focused measures score high on the decision matrices using the sample criteria. This makes sense since system operations is a customer-centric activity. In fact, the best way to determine how well a system is being operated is to ask the customers. FIRTs regularly distribute customer feedback cards after they administer their services. A section of this card asks customers to place a dollar value on the assistance they received. Table 8 summarizes 3 month's worth of customer "valuations" of the FIRT service. This is clearly an effective measure for both the emergency and incident management functions.

Table 8. Customer Appraisal of FIRT Services During First Quarter of 2004[10]

Response	No. of Responses	Low $ Amount	Mid $ Amount	High $ Amount
No value	16	$0	$0	$0
$0-$20	23	$0	$230	$460
$20-$50	85	$1,700	$2,975	$4,250
$50-$100	45	$2,250	$3,375	$4,500
Over $100	33	$3,300	$4,125	$4,950
Total	202	$7,250	$10,705	$14,160
Average	n/a	$35.89	$53.00	$70.10

Personal Travel Services

An investigation of the use of the *511 Virginia* phone and online service was completed in January 2004.[12] This service can be accessed anytime by dialing 5-1-1 from a wireless or landline phone (home, office, etc.) or visiting the website at www.511virginia.org to obtain traffic and travel information. The project used focus groups, telephone surveys, and Internet-based surveys to assess the awareness and use of the 511 service, as well as overall customer satisfaction. Table 9 presents a summary of the findings of this study. Measuring customer

Table 9. Results from *511 Virginia* System Evaluation[12]

Study	Data Source	Sample Size	Awareness	Usage	Customer Satisfaction
Focus Group	Commercial Vehicle Operators	12 participants	33% (4 participants)	0% (0 of 4 participants)	N/A
Focus Group	Tourists	8 participants	0% (0 participants)	N/A	N/A
Focus Group	Virginia Residents	21 participants	48% (10 participants)	40% (4 of 10 participants)	N/A
Web Survey	511 Virginia Website Users	108 respondents	N/A	69% (75 respondents likely to revisit on regular basis)	63% (68 respondents)
Phone Survey	Commercial Vehicle Operators, Tourists, Virginia Residents	19 CVO participants, 154 tourist participants, 227 resident participants	N/A	Aggregate for CVO, tourists, and residents: 99% (397/400) would call service again	Aggregate for CVO, tourists, and residents: 24% (95/395) found service somewhat useful, 66% (260/395) found service very useful
Awareness Survey	Virginia Coverage Area Residents	385 participants	19% (73 participants)	8% (6 of 73 participants)	N/A
Awareness Survey	Virginia Residents	1,099 participants	13% (139 participants)	7% (10 of 139 participants)	N/A
Data Analysis Report	511 Virginia Phone Service Users	210,052 calls	N/A	210,052 calls over 18 months	N/A
Data Analysis Report	511 Virginia Website Users	117,420 visits	N/A	117,420 visits over 18 months	N/A

awareness and use of a traveler information service is beneficial in evaluating the effectiveness of personal travel services. Measures from tables such as these can be synthesized and used to help determine how best to apply future resources; for example, in this case, the system is sufficient, but current advertising efforts are not.

Step 6: Finalize List of Performance Measures

The final step in the framework is compiling the final list of performance measures to be used. As part of this effort, it is also necessary to determine what additional data sources (if any) are needed to accommodate the compilation and reporting of the final measures. As mentioned previously, the model is an iterative process and should be revisited regularly to ensure that the best possible performance measures are being used.

Tables 10 through 12 show the recommended performance measures for HRSTC that resulted from the example application of the six-step framework.

Table 10. Recommended Performance Measures for "System Management"

TRAFFIC MANAGEMENT
Number of STCs integrated with HRSTC
% required HRSTC/FIRT positions filled
Travel time reliability
% customer satisfaction with HRSTC
INCIDENT MANAGEMENT
% customer satisfaction with FIRT
Average incident response time
FIRT coverage (lane-miles, vehicle-hours)
% ITS devices operational
% detections, by type of detection
TRAVEL DEMAND MANAGEMENT
HOV lane volume
HOV lane average speed versus regular lanes
HOV lane hours of operations
Time to reverse direction of RHOV roadway
ARCHIVED DATA FUNCTION
% data that are "complete" or "usable"
Number of data collection stations
Number of STCs integrated with ADMS

Table 11. Recommended Performance Measures for "Emergency Management"

EMERGENCY NOTIFICATION AND SECURITY
Number of agencies integrated with HRSTC
Frequency of emergency communication tests
% ITS devices operational
Customer awareness of HRSTC services

EMERGENCY VEHICLE MANAGEMENT
Average incident response time
% customer satisfaction with FIRT/HRSTC
Number of on-call injuries to FIRT drivers

DISASTER RESPONSE AND EVACUATION
Time since last response plan meeting
Customer awareness of evacuation route
% ITS devices operational
Evacuation clearance time

Table 12. Recommended Performance Measures for "Personal Travel Services"

PRE-TRIP TRAVELER INFORMATION
Number of 511 Virginia website hits
HAR coverage area
% work zones announced ahead of time
% special events announced ahead of time
Number of calls to 511 Virginia

EN-ROUTE TRAVELER INFORMATION
Average VMS refresh time
Average HAR refresh time
% ITS devices operational

ROUTE GUIDANCE
VMS message delay after incident
% work zones with VMS messages
Average VMS refresh time
Average HAR refresh time
% ITS devices operational

TRAVELER SERVICES INFORMATION
Number of 511 Virginia website hits
HAR coverage area
Number of calls to 511 Virginia
511 Virginia coverage area

CONCLUSIONS

- This study produced a method to assess the role of STCs in system operations and will be of assistance in guiding decisions from both perspectives.

- The six-step model developed in this study will allow STC operators, managers, and other stakeholders to wade systematically through a comprehensive set of performance measures and select the most appropriate ones for their specific use. This framework presented will allow STCs to keep their performance measures aligned with the changing environment. This model can serve as the basis for the evaluation of current and future performance measures.

- Successful application of the model to the HRSTC's three primary areas of operation authenticated the procedure. The measures identified are not intended to constitute a complete list of measures for use at the HRSTC but rather show the result of a typical application of the model. The application provides an overall understanding of the performance measure assessment process and considerations that must be accounted for when using the evaluation framework.

- Because the measures used by agencies to monitor their performance must be dynamic and adaptable to changing conditions, the role of the STCs in regional systems operations will change over time.

- Consistent performance measures should be used throughout organizations for a number of reasons. First, the general comprehension of a measure is enhanced (among the public, lawmakers, etc.) when the same approach is used again and again. Second, trends can be established only by using the same measure over a period of time.

- Ideally, a "core set" of performance measures can be used at all STCs, with a small number of measures varying among STCs, depending on the unique needs of a particular center. Reporting the performance measures at regular intervals will increase the impact the measures make internally as well as the impact on lawmakers and citizens alike.

- A collection of performance measures is given in electronic fashion via a spreadsheet at http://www.virginiadot.org/vtrc/main/online_reports/pdf/list-2.xls to practitioners as a basis to initiate performance evaluations and as a means for dynamic editing of the available or recommended measures. This product should encourage VDOT officials to employ the techniques recommended by this study.

RECOMMENDATIONS

1. *VDOT STC managers should apply the six-step framework developed in this study to determine the best measures to use at their centers*. The model presented here will greatly assist STC managers and/or operators in identifying the key measures that will allow for better performance tracking, and thus, better performance.

2. *Performance measures should be drawn from existing data whenever possible.* In Virginia's case, the ADMS database provides a vast source of potential performance measures. The HRSTC incident database and the VSP CAD database are two additional and accessible sources of pertinent data. However, narrow data supplies should not limit the selection of performance measures.

3. *Inter-agency and inter-jurisdictional communication should become entrenched as an essential practice of systems operations*. Joint communication, planning, and information sharing should be formally established and practiced by all stakeholders to maximize the collective gain of the region.

COSTS AND BENEFITS ASSESSMENTS

The expected benefits of implementing the performance evaluation framework developed in this project are as follows:

- documentation of the benefits of STCs in providing specific services and their contribution to the overall goals of a region's system operations
- identification of areas where improvements in STCs can be made to benefit the system operations and, hence, the traveling public
- a tool that can be used to prioritize new functions or enhancements to existing services; accordingly, the use of performance measures can be used to justify expansion, upgrades, and enhancements for individual STCs
- definition of cost-effective services that can be used to expand, standardize, and guide the new and emerging STCs.

FUTURE RESEARCH NEEDS

Future research is needed to develop ways that ensure the proper reporting of performance measures. The most complete and understandable performance measurement system is of little use if it is not effectively shared in a timely fashion with other stakeholders, elected officials, and most important, the customer. Some agencies do a better job of presenting and reporting their performance measures than others. These organizations are able to generate additional funding because of the effective marketing of their performance measurement program. This study could include an investigation of proper reporting intervals, display techniques, and methods of dissemination.

ACKNOWLEDGMENTS

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REFERENCES

1. Allen, G.R.. Internal correspondence, Virginia Department of Transportation, Richmond, March 2, 2004.

2. Lockwood, S. *Description of Transportation Systems Operations and Management*. Federal Highway Administration National Dialogue on Operations. Federal Highway Administration, Washington, D.C., 2001. http://www.ops.fhwa.dot.gov/nat_dialogue.htm. Accessed July 2005.

3. Virginia Department of Transportation. *VDOT Leadership—Chief of Systems Operations*. Richmond, 2004. http://www.virginiadot.org/infoservice/news/is-newsctr-bio-sorrell.asp. Accessed July 2005.

4. Federal Highway Administration, Office of Transportation Management. *Freeway Management and Operations Handbook*. Washington, D.C., 2003.

5. TransTech Management, Inc. *Strategic Performance Measures for State Departments of Transportation: A Handbook for CEOs and Executives*. National Cooperative Highway Research Program, Washington, D.C., 2003.

6. Meyer, M.D. *Measuring System Performance: The Key to Establishing Operations as a Core Agency Mission*. Paper presented at the Annual Meeting of the Transportation Research Board, Washington D.C., January 2002.

7. Atkinson, J. *TMC Performance Measures Survey*. University of Virginia Center for Transportation Studies, Charlottesville, 2004.

8. Virginia Department of Transportation. *Smart Travel Implementation Framework*. Richmond, June 2004. http://www.virginiadot.org/infoservice/resources/prog-smarttravel-framework04.

9. Berman, W. *Advanced Transportation Systems Management and Operations: The Need for a Regional Perspective*. Presentation to the Regional Transportation Systems Management and Operations Committee. Park City, Utah, July 27, 2004.

10. Virginia Department of Transportation. *Hampton Roads Freeway Incident Response Team (FIRT) Impact Study*. Richmond, April 12, 2004.

11. Smart Travel Laboratory. Archived Data Management System. University of Virginia Center for Transportation Studies, Charlottesville, January, 2005. http://cts.virginia.edu/stl_adms.htm. Accessed July 2005.

12. Swan, N. et al. *11 Virginia Evaluation*. Virginia Tech Transportation Institute, Blacksburg, January 2004.

APPENDIX

TMC SURVEY RESULTS[7]

1. TMC and contact information

1. TMC and contact information	
#	Response
1	Patti G. Newsome, Incident Management Engineer, NCDOT Division 9 TMC, 375 Silas Creek Parkway, Winston-Salem, NC, 27127, 33-703-6660, pnewsome@dot.state.nc.us
2	Patrick Wilson, PE, Regional ITS Engineer, Piedmont Triad Regional TMC, 201 S. Chimney Rock Road, Greensboro, NC, 27409, (336)315-7080, pwilson@dot.state.nc.us
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4	Jim Mitchell, Freeway Operations Engineer, WSDOT Olympic Region TMC, 2502 - 112th Street East, Tacoma, WA, 98445-5104, (253) 536-6020, mitchej@wsdot.wa.gov
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7	Tai Nguyen, ITS Manager, TransVISION, PO Box 6868, Fort Worth, Texas, 76115, 817.370.6624, tnguy@dot.state.tx.us
8	Scott Campbell, Transportation Engineer, Bridgeport Operations, 149 Prospect Street, Bridgeport, CT, 06604, 1-203-696-2681, scott.Campbell@po.state.ct.us
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10	Brian G. Fariello, Traffic Management Engineer, TransGuide Operations Center, 3500 Northwest Loop 410, San Antonio, Texas, 78232, (210) 731 5247, bfariel@dot.state.tx.us
11	. . . . .
12	Leo Jackson, Manager Traffic Operations Center, Traffic Operations Center, P.O. Box 1121, New Brunswick, New Jersey, 08903, 732-247-0900 Ext 5575, jackson@turnpike.state.nj.us
13	R. Steven Bridges, MRTMC Operations Engineer, Metrolina Regional Transportation Management Cente, 2327 Tipton Drive, Charlotte, NC, 28206, 704-342-6814, sbridges@dot.state.nc.us
14	ray webb, TOC Mgr, KC Scout, 600 NE colbern rd, lees summit, mo, 64081, 816 622-0520, raymond.webb@modot.mo.gov
15	Santa Ana, Richard, TMC Supervisor, Oregon DOT / Traffic Management Operation Center, 123 NW Flanders St, Portland, OR, 97209, 503-731-4995, richard.santaana@odot.state.or.us
16	Troy Boyd, ITS Operations Manager, Borman Traffic Management Center, 7701 East Melton Road, Gary, IN, 46406, (219)-939-3650, tboyd@indot.state.in.us
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19	Dan Campbell, Signal System/ ITS Coordinator, SCDOT State TMC, 955 Park St., Columbia, SC, 29201, 803-737-1893, campbellde@scdot.org
20	Emilio C. Sosa, Director, INFORM, 250 Veterans Memorial Highway, Hauppauge , New York, 11788, 631-952-6733, esosa@dot.state.ny.us
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22	Kamal Hamud, Supervisory Civil Engineer, District of Columbia, 2000 14th Street, NW, Washington, DC, 20009, 202-671-1497, Kamal.Hamud@dc.gov
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27	Teresa Krenning, TMC Manager, Transportation Management Center, 14301 South Outer Forty, Chesterfield, Missouri, 63017, 314-340-4100, teresa.krenning@modot.mo.gov
28	Maria (Mia) Silver, Operatons Manager, Michigan Intelligent Transportation Systems Center, 1050 6th Street, Detroit, MI, 48226, 313-256-9800 x304, silverma@michigan.gov

2. At what stage of development is your TMC? Is your TMC operational in that ITS functions are being carried out routinely, or is your TMC working to develop an ITS program?

2.	At what stage of development is your TMC? Is your TMC operational in that ITS functions are being carried out routinely, or is your TMC working to develop an ITS program?
#	Response
1	currently functioning routinely
2	New TMC to be operational by the end of 2004. CCTV operation DMS operation HAR operation Public Information
3	Our TMC is fully developed, however we're continuously upgrading and adding newer features/technology as funding becomes available.
4	ITS functions are being carried out routinely, but we are still a work in progress.
5	Mature, currently functioning system but salways under development. See Reading Room - http://www.chart.state.md.us/readingroom/readingroom.asp
6	We have been semi-operational for the past two years with 6.2 miles of roadway coverage. The ITS system will expand to over 30 miles of coverage in December. There is an operational contract in place to begin handling 24/7 operations in October.
7	Operational
8	Bridgeport Operations has been up and running since Dec. 1994
9	operational
10	The TMC has been in operation for 9 years. All agencies originally envisioned to be part of the TMC have work space here (TxDOT, police, transit, City traffic signal operations). ITS functions are carried out routinely.
11	Operational 24/7
12	Fully Developed
13	We operate ITS functions routinely but are expanding quickly and are looking to update our detection to a travel time system.
14	Operational Jan. 2004, 5:30 am to 8:30pm
15	Full ITS functions
16	TMC fully operational
17	TMC is operational in that ITS functions are being carried out routinely
18	100% operational. MassHighway has a 24/7 TOC which operates statewide. We use an integrated software system call MassTERS, which was developed and implemented by IBI Group. The TOC performs ITS functions routinely, from declaring incidents on the roadway which produce a response plan with DMS to tracking our CaresVan program with GPS.
19	Functionally operational
20	Running 24/7
21	Our TMC are operational in that ITS functions are being carried out routinely
22	Our TMC is some what functional. We have some elements of ITS in place such as arterial CCTV surveillance. However we are still developing freeway management and surveillance system.
23	The TIMS system is operatinal at this time and has been for 1.5 years. As we use our system, we identify areas of enhancements. I anticipate this process to continue for the next few years.
24	Our TMC has been operational since 1995
25	Its Operational
26	The TMC was fully operational on November 2000.
27	We are operational 24/7 with dispatching, CCTV, DMS, and incident response crews.
28	existing operational TMC

3. What is your annual operational budget?

3. What is your annual operational budget?	
#	Response
1	$850,000
2	$2.2 million
3	Approx. $6 Mill
4	$ 535,000 for TMC $ 605,000 for Incident Response Program
5	$6.5 million
6	$225,000
7	???
8	$1,000,000/year for operations
9	determined by state office in Columbia
10	TxDOT's operational budget is $1.2 million per year
11	Personal Services (20FTE state employees) = 1,484,067 Operating Expenses (Telecom, toll free expense, phone system, rent, power, etc) = 1,442,025 Contract Staff (includes electrical services, operations, maintenance, systems support and minor purchases less than 5K of equipment) = 3,000,000
12	
13	Around 4.6 Million
14	Currently under review but $4-5m
15	ITS Maintenance 677k, TMC 1.5M, Incident Response 1.5M
16	approximately 200K without payroll
17	$830,000.00 (Expense plus field work budget)
18	$300,000 per year
19	$1,000,000
20	$2.5 mil including radio / emergency dispatch center
21	About 1 Million to cover mostly staff salaries.
22	Less that $500,000.00
23	$2.5M
24	300000
25	Salary Budget: $250,000/year Maintenance Budget: $1,500,000/year
26	TMC staffing only - approx. $500K Inc Response budget - approx. $1.4M TMC facility - approx. $400K
27	roughly $2M maintenance, $1.3 control room operations, $3.6M freeway courtesy patrol, $1M other (small contracts and purchase orders, staff for operations)

4. How many centerline miles with real-time traffic data collection technologies do you manage?

4. How many centerline miles with real-time traffic data collection technologies do you manage?	
#	Response
1	0
2	140 miles
3	150 miles
4	8 miles
5	155
6	Approximately 32
7	40 miles
8	approx. 56 miles
9	43
10	93 miles
11	Estimated 150 miles
12	148
13	32 miles
14	75miles
15	75 miles, 1 type loop detection
16	21
17	At this time 17.5 miles
18	100 miles
19	75
20	210
21	140 miles
22	Right know we have about 5 center mile. By the ed of this we hope to have about 20 centerline miles covered.
23	274 centerline miles provide travel time information. 130 centerline miles for RTMS data. 274 centerline miles for cctv coverage and DMS coverage.
24	100
25	75
26	75 miles
27	Our devices are located at strategic points, however we are constructing devices in between now. We have approx. 18 points of monitoring now, so mileage is difficult to calculate. The incident response operation covers over 160 centerline miles.
28	roughly 200

5. How many total employees are on staff at your TMC?

5. How many total employees are on staff at your TMC?	Number of Responses	Response Ratio
Less than 25	19	68%
25-49	6	21%
50-99	2	7%
100 or more	1	4%
Don't know	0	0%
Total	28	100%

6. What percentage of your employees are privately-contracted employees?

6. What percentage of your employees are privately-contracted employees?	Number of Responses	Response Ratio
0%	13	46%
1%-24%	8	29%
25%-49%	1	4%
50%-74%	1	4%
75%-100%	5	18%
Don't know	0	0%
Total	28	100%

7. If your TMC hires contracted work, what jobs are given to contractors? Check all that apply.

7. If your TMC hires contracted work, what jobs are given to contractors? Check all that apply.		Number of Responses	Response Ratio
Software development/IT		17	65%
Dispatcher positions		7	27%
Management		4	15%
Secretaries		1	4%
Performance evaluations		3	12%
Planners		1	4%
Incident Response Team drivers		5	19%
None of the above		5	19%
VIEW Other, Please Specify		12	46%

7. If your TMC hires contracted work, what jobs are given to contractors? Check all that apply.	
#	Response
1	towing operations on the roadway
2	Bldg. maintenance
3	Some maintenance
4	Operations staff/PIO
5	Maintenance of IT and field equipment
6	equipment maintenance
7	TMC operators are interns (from the University)
8	System maintenance
9	Systems/network/field devices evaluation
10	Field Work
11	TMC field equipment maintenance
12	ATMS operators

8. What ITS functions does your TMC currently use? Check all that apply.

8. What ITS functions does your TMC currently use? Check all that apply.	Number of Responses	Response Ratio
Closed-circuit television monitoring	28	100%
Variable message signs	28	100%
Variable speed limit signs	4	14%
Automated collision notification systems	2	7%
Traffic signal coordination	10	36%
Ramp metering	9	32%
Lane control signals	6	21%
HOV system	8	29%
Electronic fare payment	0	0%
Electronic toll collection	1	4%
None of the above	0	0%
VIEW Other, Please Specify	11	39%

8. What ITS functions does your TMC currently use? Check all that apply.	
#	Response
1	Highway Advisory Radios
2	HAR, Speed Sensors, Weather Stations
3	Vehicle Detection
4	Highway Advisory Radio
5	speed detection
6	HAR, Website (Cotrip.org)
7	HAR
8	in the future ramp meters
9	Travel time estimation, ATIS
10	Vehicle detector system
11	vehicle detection devices

9. What ATIS methods does your TMC use to distribute information to the public? Check all that apply.

9. Which ATIS methods does your TMC use to distribute information to the public? Check all that apply.		Number of Responses	Response Ratio
Web site		28	100%
Dedicated cable TV		7	25%
Kiosks		4	14%
Automated telephone system		11	39%
In-vehicle navigation systems		0	0%
Notifications by email, pager, or cell phone		15	54%
None of the above		0	0%
VIEW Other, Please Specify		14	50%

9. Which ATIS methods does your TMC use to distribute information to the public? Check all that apply.	
#	Response
1	CMS, Fax
2	Local cable TV in a.m. & p.m. peak
3	VMS, HAR, Notification to Media
4	Television News Media
5	Media
6	Media connects directly to video cameras
7	HARs
8	Low Power UHF Television broadcast
9	Broadcast Fax, HAR
10	Traffic Services, Shadow and Metro
11	video to media
12	HAR, VMS, local media and service provider
13	Hwy Condition Reporting System
14	on site media and feeds to media

10. If your TMC has its own web site, what information is presented on it? Check all that apply.

10. If your TMC has its own web site, what information is presented on it? Check all that apply.	Number of Responses	Response Ratio
Construction delay information	16	59%
Incident statistics	2	7%
Incident delay information	13	48%
Travel time	3	11%
Weather-related delay information	8	30%
CCTV images	23	85%
Current variable message sign displays	6	22%
None, no web site	2	7%
VIEW Other, Please Specify	14	52%

10. If your TMC has its own web site, what information is presented on it? Check all that apply.

#	Response
1	info is on a "statewide" site which includes 4 TMC
2	Travel conditions, speed, closures
3	current travel speeds, counties in snow emergency
4	HAR, Road weather info etc...
5	Highway Advisory Radio Messages
6	Using the statewide TIMS website
7	real time speed - www.kcscout.net
8	Speed condition map for Portland Metro area
9	genral information about the Sunguide program
10	via our ATIS provider, SmartRoutes Systems
11	Reversible lane status
12	CCTV images are provided to DDOT wide website
13	Maintenance activities
14	speed map, and current incidents

11. What data do you collect from your traffic monitoring procedures? Check all that apply.

11. What data do you collect from your traffic monitoring procedures? Check all that apply.	Number of Responses	Response Ratio
Average motorist speed	20	71%
Recurring delay	4	14%
Travel time	6	21%
Traffic volume	21	75%
Incident delay	8	29%
Emergency management response times	7	25%
Weather information	7	25%
None of the above	2	7%
VIEW Other, Please Specify	6	21%

11. What data do you collect from your traffic monitoring procedures? Check all that apply.

#	Response
1	delay is actually calculated from responder report
2	corridor travel speed
3	Travel times will be on board soon
4	operations: incident and Road Ranger data
5	not operational yet
6	We collect limited arterial Traffic data

12. With whom do you share these traffic data? Check all that apply.

12. With whom do you share these traffic data? Check all that apply.		Number of Responses	Response Ratio
State DOT		17	63%
Other TMCs		17	63%
Emergency personnel (fire, rescue, police, etc.)		13	48%
Local media		13	48%
Transit agencies		4	15%
Bridge/Tunnel authorities		3	11%
None of the above		5	19%
VIEW Other, Please Specify		6	22%

12. With whom do you share these traffic data? Check all that apply.	
#	Response
1	public
2	FHWA
3	City, University
4	Purdue
5	FHWA, Planning groups
6	MPO

13. Does your center archive data?

13. Does your center archive data?	Number of Responses	Response Ratio
Yes	25	89%
No	3	11%
Total	28	100%
VIEW 24 Responses		

13. Does your center archive data?	
#	Response
1	number and type of motorists assists, number of CMS and HAR activations
2	Stops by each Incident Management Assistance Patrol drivers
3	speed, incidents, metering rates,volume
4	all data
5	All vehicle travel information (speed, volume, etc.) and VMS usage.
6	Limited Traffic Volume, Vehicle occupancy
7	Incident reports CMS logs, HAR logs, Service Patrol Activities
8	RECORD RETENTION SCHEDULE
9	incident response (Dynamic Message Signs, Lane Control Signals) speed, volume occupancy
10	Daily road/weather
11	Sign changes
12	All of our Traffic Data is Archived on CD
13	Loop detector data, incident records, Variable Messages
14	30 second avg
15	Operations data: incident and Road Ranger data
16	anything that is input into the MassTERS software.
17	VSO Data
18	volumes and occupancies
19	All data
20	Volume, Speed
21	All
22	Vehicle speeds Volumes DMS messages Maintenance field work Field equipment
23	Incicent actions by TMC staff and Responder staff
24	Vol, Occ, Spd, incident data, CMS message data, courtesy patrol call card data

14. Has your TMC published any information regarding ITS performance measures?

14. Has your TMC published any information regarding ITS performance measures?		Number of Responses	Response Ratio
Yes		4	14%
No		18	64%
Not yet, but will in the future		6	21%
	Total	28	100%

15. If your TMC has published any sort of performance report, please use the space below to tell us how we may access it.

15. If your TMC has published any sort of performance report, please use the space below to tell us how we may access it.	
#	**Response**
1	kdamron@dot.state.nc.us
2	See Reading Room for evaluations from 1997, 1999 - 2002 http://www.chart.state.md.us/readingroom/readingroom.asp
3	Internal reports available for specific ITS activities
4	no
5	only beginning to look at this.
6	Portland State Univerity completed a study for our program. Robert L. Bertini, Ph.D., P.E., Assistant Professor Director, Center for Transportation Studies, Portland State University 503.725.4249 www.bertini.org
7	n/a
8	FHWA Study done around 1991
9	Performance measures are published for internal use. Our TMC can furnish a copy upon request.
10	N/A

16. If your TMC has not yet published a performance evaluation report but plans to, at what date should this report be completed?

16.	If your TMC has not yet published a performance evaluation report but plans to, at what date should this report be completed?
#	Response
1	THIS IS THE JOB OF CENTRAL OFFICE IN COLUMBIA, NOT THE INDIVIDUAL TMC
2	2005
3	n/a
4	available spring 2005
5	n/a
6	mid 2005
7	We are still developing our performance Measures.
8	We are working with all of the regional agencies to develop measures so we can all compare the same data.
9	December 2005
10	End of 2004
11	mid-2005

17. Which of the following performance measures does your TMC analyze in these reports? (If no report has yet been published, which of the following performance measures would likely be used in a performance evaluation?) Check all that apply.

17. Which of the following performance measures does your TMC analyze in these reports? (If no report has yet been published, which of the following performance measures would likely be used in a performance evaluation?) Check all that apply.	Number of Responses	Response Ratio
Benefit-cost analysis	12	57%
Incident delay analysis	13	62%
Travel time	6	29%
Crash and fatality reduction	8	38%
Emissions and fuel consumption	5	24%
Dispatcher evaluations	4	19%
Comment cards	4	19%
Motorist phone calls	3	14%
Website surveys	5	24%
Website hits	8	38%
None of the above	1	5%
VIEW Other, Please Specify	4	19%

17. Which of the following performance measures does your TMC analyze in these reports? (If no report has yet been published, which of the following performance measures would likely be used in a performance evaluation?) Check all that apply.	
#	Response
1	Year to Year Incident, delay, and P.D. resp. time
2	SEE 16
3	n/a
4	No. of devices implemented; no. of messages posted

18. Does your TMC publish performance evaluation reports periodically? (If no, then skip to question 21)

18. Does your TMC publish performance evaluations reports periodically? (If no, then skip to question 21)		Number of Responses	Response Ratio
Yes		5	21%
No		19	79%
	Total	24	100%
VIEW 6 Responses			

18. Does your TMC publish performance evaluations reports periodically? (If no, then skip to question 21)	
#	Response
1	Annual
2	Yearly statistic.
3	per month
4	CENTRAL OFFICE IN COLUMBIA
5	Quarterly
6	Annual report is submitted to management

19. In what format are the reports published?

19. In what format are the reports published?		Number of Responses	Response Ratio
Newsletter		0	0%
Formal report		5	63%
Website presentation		0	0%
None, no reports published		2	25%
VIEW Other, Please Specify		1	13%
	Total	8	100%

19. In what format are the reports published?	
#	Response
1	CENTRAL OFFICE IN COLUMBIA

20. With whom are the performance evaluation reports shared? Check all that apply.

20. With whom are performance evaluation reports shared? Check all that apply.	Number of Responses	Response Ratio
FHWA	2	29%
State DOT administration	7	100%
The public	1	14%
Contractors	0	0%
Internal personnel	4	57%
Emergency personnel (fire, rescue, police, etc.)	2	29%
Other TMCs	2	29%
VIEW Other, Please Specify	1	14%

20. With whom are performance evaluation reports shared? Check all that apply.	
#	Response
1	Published on the Web

21. Do you have any consistent benchmarks that you can use for your performance measures?

21. Do you have any consistent benchmarks that you use for your performance measures?	Number of Responses	Response Ratio
Yes	4	17%
No	20	83%
Total	24	100%

22. If certain benchmarks are used, please describe them.

22. If certain benchmarks are used, please describe them.	
#	Response
1	Please read the reports
2	n/a
3	- accident - speed - volume - occupancy
4	Response time, lane clearance time, PDO, PI.
5	Urban and rural incident response times

23. Does your TMC design performance measures suited specifically to the TMC, or are performance measures designed according to a system-wide performance monitoring process?

23. Does your TMC design performance measures suited specifically to the TMC, or are performance measures designed according to a system-wide performance monitoring process?		Number of Responses	Response Ratio
Performance measures designed specifically for TMC		4	36%
Performance measures designed for system-wide performance monitoring process		7	64%
	Total	11	100%

24. If there is anything else you would like to tell us about the performance of your TMC that was not specifically addressed in this survey, please use the space below.

24. If there is anything else you would like to tell us about the performance of your TMC that was not specifically addressed in this survey, please use the space below.	
#	Response
1	We are in the infancy stage of development. It is anticipated that the next two years will lead to dramatic changes in the way we do business.
2	SURVEY SEEMS TO BE CREATED FOR OUR CENTRAL OFFICE, NOT THE INDIVIDUAL SITE.
3	Colorado has three major TMC offices, Denver, Colorado Springs and Glenwood Springs.
4	no
5	Performance measurements are being developed through State Central ITS office and local efforts. Final draft is being developed.
6	Our TMC also develops ITS proejects for statewide implementation
7	N/A
8	initial steps focus on measuring performance (e.g. number of incidents over time) vs. impact (e.g. delay or reduction in delay at these incidents)