

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP Report 357

**Measuring State Transportation
Program Performance**

**Transportation Research Board
National Research Council**

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Report 357

Measuring State Transportation Program Performance

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Area of Interest

Planning and Administration

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation officials, or the Federal Highway Administration, U.S. Department of Transportation.

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FOREWORD

*By Staff
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This report contains a compendium of program-performance measures and indicators commonly used by state departments of transportation. A commentary is provided that puts the performance measures in an appropriate context and assists in their use. In addition, a supplemental report is included that contains discussions of methodologies and the merits and pitfalls of comparing the performance of state departments of transportation. Top level managers and, in particular, chief administrative officers (CAOs) and new managers will find both reports useful in developing processes for assessing the current condition and continuing performance of their departments of transportation.

Recent trends reveal a high rate of turnover in chief administrative officers (CAOs) of state highway and transportation agencies. New CAOs must step in and manage vast organizations with numerous functions and organizational units. To do this effectively, a new CAO, and in particular one from outside the organization or even outside the transportation industry, must know how well the agency is currently performing as a whole and within each unit. Agency-performance information is also a powerful analytical tool for experienced CAOs in tracking their own performance over time and, perhaps, for generally comparing their state to others.

Under NCHRP Project 20-24 (6)A, the Highway Users Federation for Safety and Mobility has produced a compendium of performance measures and indicators to assist state highway and transportation departments and their CAOs in evaluating and continuously improving the operational performance of their agencies. In addition to the compendium, commentary on the use of performance measures and indicators is provided and directed primarily to CAOs and other top managers.

A supplemental report titled, "Exploring Methodologies for Comparing State Highway Performance," is also published herein. The supplement documents a study conducted by Mr. Thomas F. Humphrey, Dr. Michael D. Meyer, and Dr. C. Michael Walton. This study was requested by the American Association of State Highway and Transportation Officials as a result of interest in a published ranking of the overall performance of state departments of transportation. The purpose of the study was to comment on the practice of comparative evaluations and to explore the feasibility of making valid comparisons.

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The research reported herein was performed by staff of the Highway Users Federation. The Federation is a business league whose members have an interest in the issues that surround the provision of safe and efficient highways at reasonable cost to the motoring public. Since 1946, the Highway Users Federation has been retained by governors, legislative committees, transportation commissions, transportation chief administrative officers, and others to advise on the management of their state transportation programs. Federation engineers have participated in management studies in a majority of the states.

Marshall F. Reed, who is the Federation's Manager of State Studies, was the principal investigator, while Richard Luettich assisted in carrying out the research. Both are registered engineers. Lester P. Lamm, the President of the Highway Users Federation, was also a member of the research team.

The project is part of the NCHRP 20-24 series that focuses on the needs of the chief administrative officers of state highway and transportation departments.

The following is a list of the survey assessment participants:

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MEASURING STATE TRANSPORTATION PROGRAM PERFORMANCE

SUMMARY

The objective of NCHRP Project 20-24(6)A was to isolate and define the key program-performance measures and indicators needed by chief administrative officers (CAOs) of state highway and transportation departments for effective and efficient administration of state highway and transportation programs. The special needs of newcomers to state transportation program management were also addressed.

The research effort resulted in the following products:

1. A list of 38 key program-performance measures with definitions and brief descriptions of their use.
2. A compendium of basic information for the early needs of newcomers to state transportation program management.
3. Information on the value of goal setting in measuring the performance of state highway and transportation programs.
4. Explanations of the necessity of tailoring each state's program-performance measuring and monitoring system—executive information system (EIS)—to the special characteristics of the state and its transportation program.
5. Discussion of some of the issues surrounding the use of performance measures when making state-to-state comparisons of state highway and transportation programs.

The researchers also found that the use of program-performance measures and indicators is an evolving concept. While several states have initiated comprehensive programs to develop and use such tools, no state has enough experience to cite its example.

However, the research team has employed program-performance measures in studies of transportation program management over the last 8 years. This recent experience allowed them to expand the concept and to both determine and describe the measures in this report.

Finally, the results and findings were also based on

- a survey of the 50 states, Puerto Rico, the District of Columbia, and the 10 Canadian provinces; and
 - an assessment of the survey results by a panel of experienced transportation managers.
-

CHAPTER 1

INTRODUCTION

THE NEED FOR PUBLIC ACCOUNTABILITY

Accountability is now, more than ever, the watchword of government programs. The taxpaying public is increasingly concerned about the value received for the cost of the services and products provided by government. Elected officials and their appointed program administrators are searching for ways and means to judge the effectiveness and the efficiency of authorized programs. The institution of a system for monitoring progress through selected program-performance measures and indicators is being looked upon by the public and their elected officials as necessary to judge both the value of the various government programs and the need for continued support. At the same time, appointed highway and transportation program chief administrative officers (CAOs) are looking for measures and indicators to guide their decisions on needed program changes.

This research is but the opening round of the wider efforts needed to perfect a system for monitoring transportation program efficiency and effectiveness. The conclusions and summary information provided herein should be considered as only the beginning point in state transportation officials' quest for institutionalizing a system to monitor their program's performance.

THE NEED TO TAILOR TO EACH STATE'S NEEDS

The summary information provided herein must be tailored to the wide variety of state transportation programs. All state transportation agencies have administrative responsibility for the state highway program. Some state transportation departments are responsible for all rural roads. Most share the responsibilities of both urban and rural roads with counties, cities, and towns. Some are responsible for extensive ferry systems. Others have extensive management and operating responsibility for airports. Some manage and operate state-owned aircraft. Some administer federal and state aid for airport and air traffic control system improvement. Several administer the motor vehicle titling and licensing functions, as well as the driver licensing functions. Some administer the highway patrol. Several operate railroads and public transportation systems. Most administer state and federal aid for mass transit. Some administer railroad assistance programs. Some states administer turnpikes, while other toll road authorities are autonomous agencies.

Urban transportation responsibilities are greater in some states than in others. Climate and topography also greatly vary across the nation, causing different transportation management needs. Some states' transportation systems are directly affected by heavy volumes of traffic passing through the state, while others do not lie along the nation's main travel corridors. Although

the 76-year-old federal-aid highway program has been a strong influence on uniformity in the development of state highways, there remain varying degrees of need for highway maintenance, rehabilitation, preservation, and modernization.

Environmental protection needs vary from region to region, if not from state to state. Air quality problems impact some states more heavily than others.

Each state's program varies from other states' programs in scope, mission, and strategic plan (goals). Therefore, each state must set its own measures and indicators for judging success or failure, progress or lack of progress, value or lack of value, and efficiency or lack of efficiency.

A Long Way to Go

Institutionalization of systems to monitor program performance is novel among state transportation departments. Of the 12 states whose programs were carefully evaluated during the 1984-to-1992 period, Highway Users Federation (HUF) engineers found only one had a comprehensive program aimed at measuring the current status of the transportation system as compared to earlier years. In fact, HUF engineers observe that many departments have even stopped developing and printing annual reports of progress and problems.

The Federal Highway Administration and the states have cooperative programs for monitoring some statistical information, which is combined in national summaries. Such summaries are useful to judge the overall performance of the national highway systems and the service being provided. Unfortunately, much of the information is not always suitable for evaluating individual state transportation program performance.

One especially bright spot in the monitoring of transportation program performance is the long-standing, federal/state program to monitor the condition of our nation's bridges. Since 1968, state and local governments have inspected each bridge on a 2-year cycle, and they have reported the results to the Federal Highway Administration.

However, in many cases, state transportation departments have stopped the record-keeping systems that were prevalent in earlier years. Highways are no longer being rated periodically and systematically in terms of sufficiency. Although there is renewed interest in pavement rating, most states have no historical record-keeping system to determine whether or not progress is being made in pavement structural condition or rideability.

Many of the facts about our state highway systems that were recorded and used in program analysis in the 1920-to-1960 era are no longer being collected. For example, *road life studies* are no longer being made. *Freight* information is no longer sought.

Roadside interviews to gain trip purposes, as well as *trip origins and destinations*, are no longer made.

Many of the surveys and data-collection functions have been eliminated in budget squeezes or from lack of knowledge about the value of such information in judging program efficiency and effectiveness.

Lack of Goals and Other Benchmarks

Highway Users Federation (HUF) engineers have also noted a general lack of state transportation program goals that are suitable for measuring and reporting progress toward achievement. Without sufficient knowledge of long-term trends, such goals or other benchmarks become necessary to judge success or failure in transportation program performance.

Measuring Conditions and Service

To be fair, great progress has been made in most states in both the physical condition of highways and the service provided to the motoring public. Reduction in motor vehicle fatality rates, increased lane-miles of highways, and upgraded lane widths and shoulder widths are examples of measurable program gains.

Only a few states have *long-standing* programs for measuring and reporting pavement conditions. Fewer yet have established goals for improving pavement condition or any other element of their programs.

Oklahoma's Measurements of Highway Sufficiency

Oklahoma is one exception to the previous statement. The state transportation department periodically measures the sufficiency of their entire state highway system and uses the information to judge overall program needs as well as the priority of individual highway improvements. Oklahoma DOT has measured highway sufficiency on a biennial basis since 1968.

In reviewing Oklahoma's highway sufficiency rating process, it was noted that there was a reversal in a long-standing trend of highway deterioration between the 1982 and 1984 surveys, followed by a marked, year-by-year improvement in highway conditions and service ever since.

The research team believes that it is important to set goals for such elements as highway pavement condition, bridge rehabilitation and replacement, as well as Interstate Highway System rehabilitation, and that long-range programs be established to meet such goals over a planned and specified period of time.

Goals are difficult to set and therefore the need for program-performance measures is not always clear. But there are examples of state transportation programs that have been able to take advantage of the benefits of goal setting and performance measurement. Examples of goal-driven state transportation programs are the Mississippi, Tennessee, and Oregon programs discussed in the following sections.

Mississippi Program. As a part of a 1986 HUF review of the Mississippi state highway program and its management, recommendations were made to set highway program goals and to report

periodically on the Highway Department's performance toward the achievement of the goals. One result was the formation of a 1,200-member coalition of Mississippi business leaders and legislators to set a year 2001 target for the conversion of 1,197 miles of two-lane highways to four-lane, divided highways at a cost of \$1.2 billion. In early 1987, the legislature enacted the program, set three phases of development, and established a funding package to meet a year 2001 completion schedule.

To complete the picture, the Mississippi State Highway Department issues quarterly reports on progress.

The HUF's follow-on review of the Mississippi state highway program in 1991 found that the AHEAD program was on schedule and that the AHEAD coalition remained intact. If the program goals are met, by the year 2001 Mississippi will lead the nation in miles of high-capacity highway per units of state population. (AHEAD is the coalition's acronym for Advocating Highways for Economic Advancement and Development.)

Consensus-generated and realistic goals are at the core of the Mississippi program. At the same time, periodic tracking and reporting of progress and performance toward meeting the established goals is of equal importance in retaining public support for the AHEAD program.

Tennessee Example. HUF engineers found another good example of goal setting and program-performance monitoring in Tennessee. In 1981, the Tennessee Department of Transportation, the governor, and the legislature established a 2-year goal for the replacement of 2,400 of their worst county bridges with box culverts. It was decided that there were many deficient small bridges on Tennessee's county roads that were on school routes and mail routes that would never be rebuilt unless a targeted program was developed to do the job.

Thus, \$20 million was earmarked for a state/county matching finance package. The Tennessee DOT established the criteria for bridge selection, set the list of qualified consultants to assist the counties, and set the box culvert design standards. State reimbursement of county costs was predicated on successful completion of the construction within the 24-month period. Most importantly, a 1984 HUF review found that the program's goal was met.

Oregon Example. In 1978, the Oregon Department of Transportation set a pavement condition rating goal that was followed until the late 1980s. Through "windshield surveys" of Oregon roads and through evaluation of ODOT's annual pavement rating survey records as well as evaluations of ODOT's maintenance and construction programs, HUF engineers tracked the steady improvement in the rideability of Oregon's state highway system.

Assessing Work Performance

Except for several states, which have long experience in the use of maintenance management systems developed to manage highway and bridge maintenance activities, there are very few cases where standards are used to evaluate individual or unit job performance or productivity.

Though many states have not yet developed fully operational maintenance management systems, Oklahoma and Maryland are

examples of state highway departments that have perfected their systems over many years of trial and error—as well as perseverance—to gain acceptance by their workers. These perfected maintenance management systems greatly facilitate maintenance managers in their testing and setting of goals and budgets for maintenance manpower, equipment, and material needs. Maintenance management systems also give maintenance managers the capability of comparing work output and cost among the various maintenance crews and highway districts, in relation to established performance standards. These systems are important to transportation programs because they aid in the management of the greatest proportion (normally 50 percent) of the typical state highway or transportation department complement of employees.

By comparing results from other states, or from historical data, or through the experience of their managers, all states could gauge the manpower, equipment, time, and cost requirements of many costly elements of their transportation programs. Most, however, are not as yet using such information to *systematically* measure and improve efficiency and effectiveness.

Oregon's Performance Measurement System

Oregon is among several states that are currently moving to institutionalize programs aimed at improving productivity through the use of performance measures for all state government departments and functions.

In 1989, the Oregon Department of Transportation (ODOT) established an Office of Productivity that reports to the Director. Its primary function has been to set a mandate to develop and implement a statewide performance measurement system.

Two levels of performance measurement have been established by ODOT: "Division-Level Measures"—program measures—and "Crew-Level Measures." Five program-performance measures have been established for the Motor Vehicle Division and 35 program-performance measures have been established for the Highway Division. After evaluation by the research team and the survey assessment participants, some of the Division-Level Measures were included in the 38 program-performance measures specified in Chapter 4.

As of mid-1991, ODOT's Office of Productivity had set 110 crew-level performance measures for nine major highway pro-

gram processes. While evaluation and identification of crew-level measures are beyond the scope of this project, the researchers note that crew-level measures are of primary use to section managers, such as the managers of highway and bridge design teams and survey crews. Thus, more research is required to expand the use of performance measures to the many management processes of the typical state transportation program.

NEW FEDERAL MANDATES FOR IMPROVED MANAGEMENT SYSTEMS

The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) requires all states to develop, establish, and implement management systems for

- highway pavement,
- bridges,
- highway safety,
- traffic congestion,
- public transportation facilities and equipment, and
- intermodal transportation facilities and equipment.

States which have not begun implementing such systems by September 30, 1995, may have up to 10 percent of their highway and transit funds withheld.

These management systems will require setting goals and evaluating progress toward meeting the goals, which add even more urgency to the effort of developing appropriate program-performance measures.

Executive Information Systems

Some states have initiated plans to establish better centralized control of their transportation programs through the establishment of executive information systems (EIS). Such computer-aided systems are aimed at giving chief administrative officers and their top management teams periodic status reports on key program-performance measures. This report should be especially important to these efforts.

CHAPTER 2

THE RESEARCH ELEMENTS

Four major activities were conducted as part of this research effort. They include:

1. A survey of the 50 states, the District of Columbia, Puerto Rico, and the 10 Canadian provinces. A questionnaire, directed toward state transportation department chief administrative officers (CAOs), was assembled that listed a wide array of possible measures for judging program performance (see Appendix B). Each CAO was asked to judge the applicability of each measure and to add other measures or indicators that were deemed appropriate. The CAOs were also asked to forward manuals and guidebooks that have been developed in their department to judge program performance.

2. A summary of the survey results. The survey and the summary of responses are appended. All identification with individual states has been removed.

3. An assessment of the survey results. A small team of persons (see Appendix A and Acknowledgments) with long experience in, or association with, state transportation program management was assembled to assess the survey results and to advise the researchers on the final report. The assembled team also analyzed the program-performance measurement guidebooks that Florida and Oregon officials included in their questionnaire return packets.

4. The final report.

CONCLUSIONS FROM THE SURVEY AND ITS ASSESSMENT

Forty-two states, the District of Columbia, and eight Canadian provinces returned completed questionnaires. Several conclusions were drawn from the survey.

Interest Is High. The large number of responses, letters, and telephone queries about the survey and the requests for the final report indicate a high degree of interest in the subject of program-performance measures.

The Survey and Workshop Confirmed the Needs. The survey and the workshop, which was held to assess survey results, were the primary vehicles for the establishment of the 38 program-performance measures identified in this report. The definitions stem from the experience of the research team in dealing with transportation program management issues.

Universal Agreement on Some Measures. As can be seen in the appended survey results, most of the measures cited within the

category of "Highway Needs and Conditions" and "Highway Safety and Risk Management" scored high as being appropriate in evaluating program progress over time. Some of these also scored high as being "desirable" in judging program performance in comparison with other states.

Making State-to-State Comparisons. Highway Users Federation (HUF) engineers have found over the years that state highway and transportation administrators have shown interest and concern about comparing their program with the programs of other states.

Furthermore, it was found that comparisons, if used judiciously, do provide important insight into the state program being analyzed. In some cases, such information has led to recommendations for change. Therefore, the survey asked state officials to judge the applicability and utility of each posed measure or indicator in both a time context and a state-to-state, comparative context. While the survey results clearly show the feasibility of comparing many measures with other states, the written comments often cautioned about the desirability of doing so.

Using Comparable State Program-Performance Measures. State-to-state comparisons have proved to be highly useful in HUF reviews of state transportation programs. However, experience has shown that (1) great care must go into the selection of comparable states and (2) the resultant facts have to be interpreted judiciously.

Data about the review state that fall outside the range for comparable states sometimes lead to recommendations for change but only after detailed examination of the reasons for the wide differences. For example, in evaluating a state's construction management staff size, explore further the reasons for the review state's complement of say, four persons per million dollars of construction contract expenditures, when several comparable states' complements range between one and two persons. In some cases, there is a sound basis for the differences. In other cases, evidence supports suggestions for reevaluation of either construction management staffing, or processes, or both.

Also of paramount importance in state-to-state comparisons is the comparability of the data employed in the analysis. It has been necessary to use carefully drafted and tested questionnaires when soliciting comparable data. Even then, follow-up is needed to make certain suspect statistics.

Each state has its own conventions and nomenclature. The questionnaire must be explicit in order to gain useful information. Again, using construction management complements as an example, it is important to determine the extent that states employ consultants or part-time help to augment staff resident engineers, surveyors, and inspectors. It is also important to determine the

extent that each state relies on the construction contractor for surveys and staking.

While state-to-state variations must be accounted for in comparative analyses, it was concluded that such studies are important indicators of both the positive aspects of state transportation programs as well as their shortcomings.

Target the Needs of the New CAO. After reviewing the survey results, there was consensus among survey assessment participants and the research team that this research report was an opportune vehicle to specify all the important early-on information needs of a new transportation department CAO. Much of this basic information is also needed for the specification and definition of program-performance measures.

Differentiating Between Program-Performance Measures and Inventory Information on Services and Facilities. From the large number of departments that checked the "currently in use" boxes of the research questionnaire, the research team and the survey assessment participants judged that the respondents were indicating that the information was part of the department's inventory of

facilities and services, but not necessarily a measure being employed *systematically* by top management in monitoring program performance. This conclusion is based on the research team's and the survey assessment participants' observations that there is a general lack of organized systems of measures in use by top management to judge transportation program efficiency and effectiveness.

Organization of the Report

The research team and the workshop assessment participants reviewed each measure cited in the survey and determined whether it was an important inventory element to be discussed in Chapter 3 or a key measure to be included in the list of program-performance measures presented in Chapter 4. Chapter 3 also presents useful information targeted to newcomers in transportation program management, and Chapter 5 summarizes the research results. Survey assessment participants and a summary of the survey process are presented in Appendixes A and B, respectively. This report also contains a supplemental section that describes the issues and challenges associated with making state-by-state comparisons of highway and transportation programs.

CHAPTER 3

NEEDS OF THE NEW CHIEF ADMINISTRATIVE OFFICER

Because the research objective is so closely tied to the needs of those *new* chief administrative officers (CAOs) that have little experience in transportation program management, the research team and survey assessment participants felt compelled to focus part of their effort on the early-on needs of such persons. The needs were addressed within three broad questions.

1. What is the program mission and the CAO's scope of responsibility?
2. What are the resources to get the job done?
3. What information is available to assess the status of the program?

The questions focus on much of the information needed to develop program-performance measures.

TRANSPORTATION PROGRAM MISSION AND SCOPE

Immediately upon taking office, a new CAO must be briefed on the overall mission of the Department. The CAO must quickly become acquainted with his or her responsibilities and which of these are the most critical.

If the mission is limited to the state highway program, the CAO must be briefed on the main elements of maintenance, construction, and project development and where each stands in terms of meeting goals and other obligations.

If the program is broader than highways—and includes motor vehicle titling and licensing, operator licensing, highway patrol, aeronautics, mass transit, railroads, waterways, or some combination of these—then the current commitments for each such element must be outlined.

Often, there are critical areas that the CAO should become familiar with early on. And there are political, fiscal, and morale issues that must be dealt with, also. The status of critical legislation is of particular importance because one of the new CAO's major responsibilities is to testify for the transportation department on policy issues.

Each state often has many transportation improvement projects in various stages of development that have sensitive community and/or environmental consequences. The new CAO will need to be briefed on all sides of the issues and be prepared to evaluate existing policy and to enunciate changes that he or she deems prudent.

Most states have a state-aid program to local governments, and the CAO must know the nature of the program and its limitations. City, county, and town officials need to be able to voice their pleas and concerns about the state program as it relates to the needs of their jurisdiction.

The new CAO must know the main state transportation department functions for which he or she has responsibility. The following is a list of possible functions of a state transportation department:

- Planning for the most effective and efficient use of resources in meeting the public need for safe and efficient transportation facilities and services;
- Establishing specific goals for the state transportation program;
- Maintaining management information systems needed to monitor the performance of the transportation program;
- Designing new or refurbished public facilities, including some or all of the following—highways, bridges, rest areas, parkways, toll roads and bridges, rail transit systems, bus systems, park and ride systems, airports, and ferries;
- Contracting for the construction of new or refurbished facilities;
- Purchasing property needed for the expansion of the transportation system;
- Controlling access to state highways;
- Evaluating environmental effects of improvement projects;
- Contracting for engineering and other specialized services not available in the department;
- Maintaining and preserving transportation facilities within the jurisdiction of the department;
- Ensuring the proper placement of traffic control signs, signals, and markings;
- Administering the state traffic safety program;
- Operating ferry service, airports, toll roads and bridges, lift spans, rail and bus systems, and rest areas;
- Licensing vehicles and operators;
- Weighing, measuring, and inspecting trucks to ensure that they meet legal standards;
- Permitting trucks with specialized loads to operate on the state highway system;
- Collecting those fees and taxes that are specified by law as being within the domain of the transportation department;

- Enforcing the rules of the road when such responsibilities are within the jurisdiction of the transportation department;
- Cleaning up after accidents on the state highway system or other transportation systems owned by the state;
- Providing disaster assistance when such disasters affect the transportation facilities owned by the state;
- Managing the motor vehicles and equipment that are owned by the department;
- Managing the buildings and grounds that are owned or otherwise assigned to the jurisdiction of the department;
- Testing of materials used in the construction, preservation, and maintenance of the state highway system and other systems that are within the jurisdiction of the transportation department;
- Researching improved materials and methods used by the transportation department;
- Providing advice and counsel to the public and elected officials on the laws (or impending laws) that pertain to the management of the state transportation systems;
- Administering state and federal transportation grants that are directed to other transportation jurisdictions within the state;
- Providing technical advice and counsel to the officials of other transportation jurisdictions within the state;
- Maintaining inventories of those transportation facilities and services that are managed by the state transportation department;
- Recruiting and retaining the staff needed to administer, manage, and operate the state transportation system;
- Organizing and managing a staff to efficiently and effectively discharge the responsibilities of the department;
- Providing advice and directions to tourists and others operating on the state highway system or otherwise making use of state transportation systems or services of the department;
- Providing information to the public and its elected officials about the department's use of public resources; and
- Controlling and conserving fiscal resources.

Not all of these functions are applicable to every state transportation department; however, there may be other functions that are assigned in specific cases. Furthermore, there are a host of minor functions of state transportation departments not cited in the list.

Whatever the total listing of functions in a given state, it is recommended that performance measures be established by each functional manager and used to judge productivity among functional units, teams, crews, and so on, as well as to compare productivity with planned goals and with previous years' work. For the most part, these performance measures are needed tools for the functional managers. Those that are important to the CAO are described in Chapter 4.

TRANSPORTATION PROGRAM RESOURCES

The second most important item of concern for new CAOs is the resources available to accomplish the program mission and functions. The most important resource elements available to meet the program mission are listed below:

Human Resources. The CAO must become acquainted with the numbers and types of people employed by the department. He or she should have a quick overview of the nomenclature used to describe the human resources, such as full-time positions, temporary positions, seasonal positions, full-time equivalent employees or other terms common to the state. The numbers of filled positions as compared to vacancies is also needed.

The reasons and benefits of reliance on temporary and seasonal employees should be made clear.

The availability of an employee handbook should be discussed, as should the availability of a long-range plan for recruiting, training, and retaining staff.

Some background on the classification system used to describe and account for the various types of employees is important to the new CAO. A summary of the numbers of persons in each employee class with a description of the functional class is basic information needed by the new CAO.

A description of the employee positions that are difficult to fill is important to the new CAO, as is an overview of age and length of service profiles of the existing staff. Dossiers of the top management team should be furnished to the new CAO. Staff turnover rates—for retirement and other reasons—should likewise be furnished, as should projections of retirements.

The role of engineering and other private consultants is important, as is the experience and background of the key consultants. Likewise, the role of construction contractors and the identification of key contractors should be included. A description of the processes used to select, evaluate, and retain consultants and contractors is also important.

The CAO should be cognizant of any executive or legislative mandates for dollar or staff limitations or freezes, commitments on taxes, or use of private forces, and how such mandates are being implemented.

How the department is organized is important as are the systems by which the CAO communicates with staff, the staff communicates with the CAO, and the staff communicates with each other. The reasons for close association of certain functions within the organization should be made clear, as should the relationship between the headquarters and field functions.

Plant. The numbers of department buildings and their location throughout the state should be addressed in an early-on orientation of the new CAO. A description of space leased to other organizations is important information, as is a description of the buildings or space leased by the department. Office space problems should likewise be made known to the new CAO.

The existence, or lack of existence, of a multiyear capital improvement plan for the modernization and rehabilitation of buildings and storage areas should be made known along with the status of the plan and its critical aspects. Who maintains department buildings and grounds—staff or contractors—is also important to the CAO.

Equipment. The numbers and types of department vehicles and equipment and how these are deployed throughout the state should be discussed. The general condition and serviceability of the equipment needs to be known. Who services and maintains the equipment is important. Where the service and maintenance take place is important also. The availability, or lack of availability, of an equipment maintenance system and an equipment replacement plan should be made known to the CAO. He or she should know how spare parts and fuel are inventoried and controlled. Finally, the current policy on employee use of department vehicles is important information for the CAO.

Funds. The new CAO should be given the dollar value of the main budget categories along with the status of expenditures to date.

The budgeting process should also be explained, along with who is responsible for managing the process. Obviously, the new CAO should be apprised of any problems in meeting the current budget as well as possible problems of the future.

In most cases, the highway program is supported by state and federal highway user taxes and fees. Twenty-seven states have constitutional amendments that limit the use of highway users taxes to highway construction, maintenance, and administration. Highway user taxes and fees are usually accounted for in a state highway fund along with highway program expenditures.

Annual budgets and annual legislative appropriations are set based on estimates of state highway user tax receipts, the amount of cash balance in the fund, and the amount of unpaid commitments or outstanding obligations.

Federal-aid highway funds are a significant proportion of the funds available to finance the program.

The sources and extent of federal and state funds should be explained along with any limitations or constraints on the use of the funds. Matching requirements for federal-aid funds should be made known as well as requirements and limitations on their use.

It should be made known to the CAO that federal-aid for highways is available for construction, reconstruction, and rehabilitation. Most highway and bridge maintenance must be accomplished with state or local funds.

In contrast, portions of the federal funding for public transportation facilities and services are available for operating subsidies, as well as for reconstruction, construction, and replacement of rail lines, busways, buses, rail cars, terminals, stations and control systems, and other capital and maintenance costs. These guidelines should also be discussed with the new CAO.

The special features of federal grants for airport, air traffic control, railroad, waterway, and ferry system improvements should be discussed as they relate to the mission and function of the state program. The availability of specific federal funding for transportation planning, traffic safety, scenic highways, turnpikes, or any special federal fund categories applicable in the state should be discussed.

The CAO should know how all federal funds come to the state (formula, grant, discretionary application, etc.). Specific briefings should relate to newly revised intermodal and flexible features of the funds identified in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA).

State highway user taxes and fees should be explained with some historical perspective on trends. Whether the revenues are available only to the state highway program or for other

transportation programs, including those administered by other state agencies, should be discussed. The systems for tax and fee collection, as well as for distribution among legal recipients, should be known.

In most states, general funds are also available to the various transportation programs; these should be discussed. Any debt service requirements or bond limitations need to be made known to the CAO. Toll funds, airport fees, concession fees, and transit fare structures should be explained, if such are within the purview of the program.

Cash flow and month-to-month cash balances should be discussed with the new CAO as should the rationale for maintaining minimum balances to meet legal requirements.

Informational Systems. How information is managed is important to the new CAO, along with knowledge of how the various divisions of the department interact with the data servicing group. Explanation of the various systems currently being employed is important, as is the availability (or lack of availability) and status of a long-range plan for development and improvement of such systems. *Constraints*—sharing arrangements, outside control, etc.—placed on the department by other state agencies relative to the use of computers, software and data analysts need to be explained.

External Forces. Of primary importance, the new CAO must comprehend his or her authority in the development of program management policies and any required sharing of such responsibilities with the highway and transportation commission, the office of the governor, other state departments, state authorities, the legislature, metropolitan planning organizations, and local governments.

The 1991 Intermodal Surface Transportation Efficiency Act changed some of the rules for transportation program management. Metropolitan planning organizations (MPOs) now have a decisive role in mandated statewide transportation plans and in transportation improvement project selection. It is axiomatic that transportation department CAOs develop close relations with MPO officials and their planning processes.

Private interest groups or associations that represent groups of businesses and industries need to be able to express their opinions to the CAO about transportation program policies that effect their members. The media need access to the CAO to obtain public interest news.

Key legislators need to have access to the CAO to determine the extent that the department is in compliance with state law. Legislative audits are usually performed periodically to learn the details of compliance or lack of compliance with state statutes.

The external groups can be powerful allies if given opportunities for access to information. On the other hand, such groups can cause problems for transportation CAOs if they are not kept abreast of policies and plans that will have a far-reaching impact on their members and constituents.

State highway and transportation officials have national and regional associations in order to address issues of common interest. In most states, the transportation department CAO represents the state and is asked to be a member of one or more committees. Often other members of the top management team also represent the department on committees and at meetings of the associations.

The CAO benefits from membership in such organizations through personal contacts with persons having similar responsibilities and problems in other states. Because these organizations sponsor forums for discussion of issues and upcoming federal policies and programs that impact each state, the CAO can gain much valuable information through membership and participation.

Because one-half or more of all financial resources are federal, federal officials maintain an oversight function. The Federal Highway Administration (FHWA) maintains an office and staff in each state to ensure that federal-aid highway funds are used as prescribed in federal statutes. The Federal Transit Administration and other federal transportation offices maintain regional offices around the nation to perform similar functions as their FHWA counterparts.

How liaison is maintained with all the external government and private entities that have transportation responsibilities and interests is a critical area that requires the attention of CAOs.

CRITICAL INVENTORY INFORMATION

The last set of highly significant information needed by new transportation CAOs is an outline of the state transportation system, its condition, and the service being provided. Critical inventory information differs from performance measures in that there are no reference points or baselines from which to judge program progress or lack of progress, efficiency or lack of efficiency, and so on. However, the inventory provides important program and system status information needed for effective top management decisions.

This section of the report presents our recommended list of critical inventory information. Some of the information is in a specific list format and other information is outlined in broader terms. The information is set forth in the following categories:

- Highway System
- Highway Travel and Traffic Densities
- Highway Conditions
- Bridges
- Traffic Safety
- Traffic Congestion
- Airports and Ports
- Intermodal Access
- Aircraft
- Railroads
- Urban Transit
- Other Urban Transportation Services
- Ferry Service
- Small Community and Rural Transportation
- Air Quality
- Tort Liability

Highway System. The miles of state highway and the proportion of total public road miles in the state that are state responsibility are critical statistics. The similarities and differences in the make-up of the state highway system as opposed to other states are likewise important, basic information for the CAO.

The miles of roads under the jurisdiction of counties, cities, and towns should be made known to the CAO. Any sharing of

responsibilities between the several jurisdictions is important. For example, in some states, all traffic signals are the responsibility of the state, regardless of whether the signals control traffic on state highways, or local roads and streets. However in most states, the traffic signals are the responsibility of the jurisdiction that is responsible for the road administration (state, city, county, or town).

In a further example, some states have formal or informal arrangements between the state highway or transportation department and the various local road jurisdictions for road maintenance. In such cases, the state maintains some county roads and county road departments maintain some state highways.

The new CAO should be cognizant of the miles of Interstate Highway along with the miles of other high-capacity (four-or-more lane, limited access) highways. He or she should also be briefed on the progress and any special problems surrounding the planning for the designation of the new National Highway System.

Some states have special designations for parts of their system. For example, the Trunk Highway System in Minnesota and the previously discussed AHEAD System in Mississippi should be disclosed. Most states have primary and secondary state highway systems and the CAO should be apprised of these systems and the functional significance of each.

Some states have designated scenic highways and these need to be identified along with any special legal features surrounding their designation.

Some states have a parkway system that falls under the jurisdiction of the state transportation department and some states have designated other authorities to manage such roads. Either way, the new CAO needs to become acquainted with such systems and any special legal implications that relate to them.

The CAO needs to know the miles of toll roads and the number of toll bridges in the state whether under the jurisdiction of the department or separate authorities.

Some states have many miles of federal roads, such as Forest Service, Park Service, and Indian Reservation roads within their boundaries. Their function and their relationship to the state transportation program as well as to the county road programs should be explained.

The federal mandate for each state to designate those highways that are to be included in the new National Highway System will be an important transportation issue in the interim period before the System's final submission to Congress for ratification in 1995.

Highway Travel And Traffic Densities. Depending on its extent, the state highway systems may carry between 50 and 90 percent of all the motor vehicle travel in the state. Even higher shares of all heavy-truck travel are generally carried on state highways or turnpikes. Except for turnpikes, state highways usually have the highest traffic densities.

The new CAO should be briefed on the proportion of all motor vehicle travel that is carried annually by the state highway system, as well as by the roads under the jurisdiction of local governments, federal agencies, turnpike authorities, and other state departments with road jurisdiction. Supplying the CAO with the average traffic densities of the roads within each general highway jurisdiction will yield a general perspective on the relative economic significance of each road system.

The CAO will gain a perspective on the magnitude of the highway service problem, if he or she is supplied with the long-term trend and projections in motor vehicle travel in the state.

The importance of safe and convenient truck travel will become obvious if the CAO is given the heavy-truck travel trend over the past 20 years along with the forecast for such travel over the future 10-to-20-year period.

Highway Conditions. Most states have a pavement condition rating process that has produced information on the relative structural condition and rideability of the state highway system. The CAO needs to know such status information.

A few states have historical information on pavement condition trends—deteriorating, improving, or remaining static—and this is vitally important information for the new CAO.

Miles of deficient highways—that is, the miles of highways not meeting minimum standards of tolerability—should be made known to the CAO. To gauge tolerability, each state should have its own minimum standards in terms of lane width, shoulder width, median width, horizontal and vertical curvature, pavement condition, congestion, safety, and so on. A track of the trends in highway sufficiency will yield valuable insight to the new CAO. A briefing on what is entailed in the measurement of highway sufficiency or tolerability is equally important to the new CAO.

All states either have developed or are developing a pavement management system to track the condition of state highway system pavement and to evaluate alternative investment strategies for maintaining various levels of pavement condition. The CAO should be apprised of the system, the current status of pavement, and how the system is being, or will be, used in determining pavement rehabilitation needs.

Bridges. The number of bridges on the state highway system, as well as on the county road system, the city street system, and the town road system should be made known to the new CAO. The condition of the bridges on each road system, based on the latest inspection survey, should also be related to the CAO.

The CAO should know other critical bridge information such as—the number of bridges in the state with load restrictions, the number of major stream spans that are structurally deficient or functionally obsolete, and the number of bridges of insufficient width to provide for two-lane traffic.

Traffic Safety. One of the elements of traffic service is safety. Traffic safety is measured through observations of the numbers of

- a) traffic fatalities,
- b) fatal accidents,
- c) injuries,
- d) injury accidents,
- e) property damage accidents, and
- f) total accidents.

Police- and driver-provided accident records are the source of such information. Depending on the state, the accident record system may be managed by the state transportation department, the state police, the governor's highway safety representative, or by

the motor vehicle department. Traffic record systems locate accidents by jurisdiction, intersection, distance from an intersection, and state highway mile marker notations.

Summary traffic safety information is often compiled on a daily, weekly, monthly, and/or annual basis.

Traffic safety is also measured on a rate basis by combining accident and miles-of-travel statistics. Traffic deaths, for example, are monitored on the basis of deaths per 100 million annual miles of travel. There are many other traffic safety statistics monitored, such as pedestrian accidents, deaths, and injuries, and wet weather accidents, deaths, and injuries. Combining basic traffic summaries with other information yields other important facts about traffic safety. For example, combining population and accident information, yields such information as traffic deaths per 100,000 population.

Traffic safety priorities may also be derived from comparisons of the cost of accidents. These summaries may yield important information for the managers of the various elements—highway, police, motor vehicle, educators, etc.—of a state traffic safety program.

The new transportation department CAO should be given at least the following critical safety information:

- a) annual traffic deaths for the past 10 years;
- b) monthly traffic deaths to date for the current year and for the same months of the previous year;
- c) annual traffic death rates for the past 10 years, and comparative national traffic death rates for the same time period;
- d) the dollar volume of annual economic losses due to traffic accidents; and
- e) last year's 10 highest traffic accident locations.

Traffic Congestion. The new CAO should be advised as to the "hot spots" in traffic congestion as well as the system used to determine mobility trends.

Several conventions are employed to determine traffic congestion. The oldest is a comparison of actual daily traffic counts with a theoretical traffic capacity for a road section or intersection. As the actual traffic approaches or exceeds the theoretical capacity, motorists are slowed. Congestion ranges are calculated to determine the relative order of congestion on the state highway, county road, town road, and city street systems.

Traffic congestion is also measured by calculations of motorists' delay times for road sections and intersections. Such calculations are made in computer simulations of actual traffic flow and checked with actual speed and delay runs on sample sections or intersections. Again ranges of delay or congestion are calculated to determine the number of road sections or intersections in varying degrees of traffic congestion.

Finally, traffic congestion is categorized by levels of service (LOS), A through E. A road section or intersection is placed in one or more of the LOS categories based on on-site surveys by experienced traffic engineers or through computer simulations of delay times.

State traffic and planning engineers often calculate the annual economic cost to motorists for statewide congestion.

The new CAO should receive a listing of the 20 congestion "hot spots," or those road sections or intersections in the state that are the most congested, whether the information be related

to volume/capacity ratios, delay times, or observed conditions. It is recommended that the new CAO also be given the facts on the economic costs to the state and its citizens attributable to congested highways.

Airports and Ports. The management of airports and ports usually falls within the purview of cities, counties, or special authorities. However, if airport and port operations are within the operational jurisdiction of the state transportation department, the number of airports managed is critical inventory information for the new CAO.

Because airports have varying classifications according to the service offered, the new CAO should be made aware of the classification system and the number of airports within each.

The new CAO should be apprised of the last 5 years' trends in annual numbers of enplanements, the number of passengers served, and the tons of freight hauled at the state managed airports.

For those state transportation departments that manage waterports, the new CAO should gain the facts on the numbers of ships served, tons of freight hauled, and gallons of fuel transferred.

The new CAO should also receive the 5-year trends in annual revenues and expenditures for both the state-managed airports and ports. He or she should also receive the number of state transportation department employees engaged in airport and port management.

Intermodal Access. The transfer of people and products between transportation modes is becoming increasingly important; thus, the new CAO should become familiar with the inventory information available and the issues surrounding such intermodal transfers.

Aircraft. Some state departments of transportation are responsible for all, or some, state-owned aircraft. The new CAO should be apprised of this aircraft fleet, the types of aircraft included, its age and condition, the complement of staff needed to operate and service the fleet, and the arrangements necessary for other state agencies to make use of the aircraft and to share in the cost of ownership and operation.

Railroads. Several state transportation departments manage commuter or other short line railroads. However, for the most part, state transportation departments merely administer state and federal grants to railroad companies for railbed rehabilitation and for commuter railroad line operating subsidies.

The CAOs of the departments that manage freight rail activities should receive a briefing on the 5-year trends in revenues, expenditures, and freight hauled. They should also receive, at the outset of their tenure, an inventory of the number of rail lines managed, the numbers of engines and cars that are in service, and the numbers of state transportation department employees involved in railroad management.

The CAOs of the departments that are administering rail line rehabilitation funds should be briefed on the extent of railroad miles in the state, the numbers of railroad companies operating

these lines, and the dollar volume of annual state and federal funds directed to the private railroads.

If abandonment of rail lines is an issue in the state, the new CAO should be briefed on the 10-year trend in annual miles of rail line abandoned and the numbers of abandonment cases pending. He or she should also be apprised of the magnitude of the economic problem to industries and communities for previous and proposed rail line abandonments.

The CAOs of the states that are subsidizing or operating commuter railroad lines should receive the following details regarding the operations:

- a) the numbers of commuter rail lines,
- b) the 5-year trend in annual revenue passengers,
- c) the 5-year trends in revenue and expenditures,
- d) the 5-year trend in average state and federal subsidy per revenue passenger,
- e) the amount of federal and state funds currently budgeted for operations or subsidies,
- f) the number of state-owned engines and passenger cars, and
- g) the number of transportation department employees involved in operations or administration.

The new CAO should also be briefed on the number of AMTRAK trains serving the state and the 5-year trend in the annual number of state citizens that embark or disembark AMTRAK trains.

Urban Transit. The new CAO should receive critically important facts regarding the state transportation program's urban transit responsibilities. Several states operate rail and bus transit systems. Most state transportation departments administer both capital and operating assistance funds to other urban transit providers.

The research team recommends that the new CAO receive the following critical inventory information regarding urban transit:

- a) the number of bus-only companies and the number of combined bus and light or heavy rail companies,
- b) the number of persons employed by each urban transit company,
- c) the number of state transportation department employees engaged in urban transit administration,
- d) the 5-year trends in both rail and bus revenue passengers for each of the transit companies,
- e) the 5-year trends in annual operating revenues and expenditures for each of the transit companies,
- f) the 5-year trends in state and federal funds received by each transit company for transit operations,
- g) the 5-year trends in state and federal capital grants directed to each urban area for transit improvements, and
- h) the proportion of each transit company's total annual operating funds that are represented by state and federal operating assistance.

Other Urban Transportation Facilities and Services. State transportation departments provide or promote other essential elements of urban transportation. Some build, operate, and maintain busways—bus-only roadways—that operate much like rail transit systems with parking and stations. Some have built or have otherwise established high occupancy vehicle lanes (HOV), so called

“diamond lanes,” on urban freeways and arterials to provide high-speed service to buses, vanpools, and carpools. Some have built park-and-ride lots to facilitate carpooling and vanpooling. Some finance or operate carpool information services to help the formation and use of shared transportation for commuting. Others are providing mechanical service to automobile breakdowns on urban freeways. Some provide emergency telephones along roadsides, as well as other communication systems, for motorists to report accidents and breakdowns and to gain emergency assistance. Some have installed metering devices—signs and signals—to facilitate urban freeway flow and to control freeway access. Some have installed interlocking traffic signal systems and centralized monitoring and control systems to smooth traffic flow, especially at peak hours of urban travel.

The new CAO needs basic information about these special facilities and services that the department is providing, or is about to provide.

Ferry Service. A number of states operate and maintain ferry services to provide basic transportation to island communities and to other isolated communities that are situated along waterways. Here, the critical inventory information for the new CAO should include the following:

- a) the names, capacities, and types of service—passengers, autos, trucks, freight, mail, meal service, lounge service, passenger sleeping quarters—provided by each of the ferries;
- b) the complement of officers and staff on each ferry;
- c) the number and types of terminals;
- d) the number of staff manning the terminals;
- e) ferry maintenance requirements and facilities;
- f) the number of staff engaged in the management of the ferry service;
- g) the 5-year trend in total revenue passengers for each ferry route; and
- h) the 5-year trend in ferry service revenues and expenditures.

Small Community and Rural Public Transportation Assistance. Many states assist in the provision of transit service to small communities and rural areas. The new CAO should be briefed on the extent of the service, its history and how the program is administered. Specifically, the new CAO should receive the following critical inventory information:

- a) the total number of small transit systems that receive state and federal assistance,
- b) the types of transit operations financed,
- c) the number of people served by each system,
- d) the amount of state and federal financial assistance each transit system receives, and
- e) the number of state transportation department employees engaged in administering the financial assistance program for small communities and rural areas.

Air Quality. State transportation programs are required to assist in the implementation of state and federal air quality standards. The new CAO should be cognizant of the role that the state transportation program has played and will continue to play in meeting the air standards.

This is particularly important in states where urban regions may not be in compliance with the standards. For those states and regions, an implementation plan has been established to bring the regions into compliance. This is a particularly vexing problem for those states where rising motor vehicle use and demand may be counterproductive to meeting the various air quality standards.

It is beyond the scope of this report to fully discuss the role of transportation in meeting air quality standards. However, it is recommended that the following information be made available early on to the new transportation CAOs of states where noncompliance with air quality standards is an issue:

- a) the 5-year trend in ambient air quality for each noncompliance region and for each of the chemicals for which air standards have been set,
- b) the goals and the action agenda included in the state implementation plans for each noncompliance region in the state, and
- c) the main transportation issues surrounding the state implementation plans.

Tort Liability. Many states are being severely impacted by legal judgments against the state and against state transportation employees regarding liability for actions or nonactions relative to the highway program functions. Most states had enjoyed sovereign immunity until recently, when changes in state laws opened up the opportunity for citizens and citizen groups to bring legal action against state employees. For those states for which risk management has become a major issue, it is recommended that the following information be given to the new CAO in the early days of his or her being named to office:

- a) a brief on tort liability law as it pertains to the state transportation program;
- b) the 5-year trend in the number and dollar volume of suits against the department and department employees;
- c) the 5-year trend in settlements or legal judgments against the department and its employees; and
- d) the program that is planned or is in effect to improve risk management, to reduce department exposure to suit, and to ameliorate tort liability claims.

State transportation programs are extremely complex. There is much information needed by new CAOs to enable them to quickly transition to a point where they can make informed decisions about transportation program policies. The compendium presented in this chapter is offered as a starting point for the transition process and for the institutionalization of a program-performance monitoring system.

CHAPTER 4

PROGRAM-PERFORMANCE MEASURES

The performance measures that are necessary for judging the overall effectiveness and efficiency of state transportation programs are outlined in this chapter. The 38 measures are subdivided into five program-performance categories, as follows:

- I. Administrative
- II. Highway Program
- III. Public Transportation Program
- IV. Motor Vehicle Program
- V. Other State Transportation Programs

Each program-performance measure is defined, with a brief description of its use. As discussed in Chapter 1, the measures specified are only a beginning point for highway and transportation departments in their institutionalization of a system to monitor program performance. No two state highway or transportation programs are exactly alike; therefore, it is likely that no two departments would elect to monitor program performance with exactly the same measures.

The measures are oriented toward the needs of the chief administrative officer (CAO), as well as those that have a transportation program policy-making role or a need to assess the overall performance of the program. This latter group could include the transportation commission, the governor's executive office, the transportation committees of the legislature, and the business interests that depend on safe and efficient transportation.

The institutionalization of a comprehensive program-performance monitoring system will mean substantial change for state highway and transportation program management. For the average state transportation department, this change will mean placing more emphasis on monitoring the condition and serviceability of the transportation systems as well as the allocation of program resources.

Obviously, a much expanded set of performance measures—beyond those set forth in the following sections—is needed to fully assess the efficiency and effectiveness of the 100 or more functional elements and subelements of state transportation departments.

I. ADMINISTRATIVE PERFORMANCE MEASURES

These are the measures needed by the CAO to judge the Department's ability to meet support services' goals and other standards. Included are the measures that relate to personnel services, budgeting, employee safety, equal opportunity, and the other major program support services.

Measure I-1: Overall Efficiency of Administrative Services

DEFINITION: These are the measures to judge the amount of resources needed for management and support services.

MEASUREMENT: Determine the 5-year trend in total costs of program management and support services as well as the proportion of total program costs represented by such costs. Compare with Department goals for such costs. Also compare with data for states of similar transportation program scope. Include the following program management and support services: personnel, training, public information, legal counsel, equal employment opportunity, budgeting, auditing, accounting, property management, and other administrative costs not directly related to the Department's operations.

Measure I-2: Labor Cost

DEFINITION: This is a measure of the resources needed for salaries and fringe benefits.

MEASUREMENT: Determine the current and past proportions of annual program expenditures devoted to salaries and fringe benefits. Compare with Department goals and similar facts about other states of comparable program scope and complexity.

NOTE: When comparisons are made with other states, consideration must be given to the amount of work accomplished by consultants and other contractors that otherwise would be accomplished by Department staff.

Measure I-3: Employees' Health

DEFINITION: These are measures of the overall wellness of the Department. They are also measures of employees' use or possible abuse of the Department's sick leave policy.

MEASUREMENT: Determine the sick leave hours taken as opposed to the hours of sick leave earned for the past 5 years as well as for each month of the current year and the corresponding months of previous year. Express the sick leave hours taken as proportions of sick leave earned.

Measure I-4: Overtime

DEFINITION: These are measures of employee performance as well as the performance of managers' in their control of resources.

MEASUREMENT: (a) Determine total program person-hours, the person-hours devoted to overtime, and their costs. Express overtime as proportions of total hours worked for the last year and for each month of the current year. Also express overtime costs as proportions of total labor costs. Compare with Department goals.

(b) Determine the overtime hours for each major program element for the past year. Express as proportions of total program cost. Compare with Department goals.

Measure I-5: Employee Safety

DEFINITION: These are measures of managers' and employees' ability to adhere to safety rules.

MEASUREMENT: Determine the annual number of employee lost-time accidents, the annual number of days lost because of accidents, and the annual premiums paid for workers' compensation for each of the past 5 years. Compare with Department goals.

Measure I-6: Equal Employment Opportunity (EEO)

DEFINITION: These are measures of the Department's ability to meet EEO goals.

MEASUREMENT: Determine the proportion of persons employed by the Department that fall within established categories—termed minorities—for the last fiscal year and the previous 4 years. Compare with established goals.

Measure I-7: Disadvantaged and Women Business Enterprise Utilization (DBE and WBE)

DEFINITION: These are measures of the Department's ability to meet federal/state goals for the utilization of DBE and WBE contractors and subcontractors.

MEASUREMENT: Determine the dollar volume of DBE and WBE contracts executed as proportions of total contracts executed for the last fiscal year and the previous 4 years. Compare with the Department's DBE and WBE goals.

Measure I-8: Budget

DEFINITION: These are measures of the Department's ability to control spending.

MEASUREMENT: Compare (a) actual and planned expenditures for each month of the current budget period (annual or biennial) and (b) actual and planned total expenditures to date for the budget period.

Measure I-9: Cash

DEFINITION: These are measures of the Department's ability to meet its obligations without either accumulating unnecessary funds or operating at a deficit.

MEASUREMENT: Compare at the end of each week or month the Department's actual cash on hand against planned minimum cash balances.

II. MEASURES OF HIGHWAY PROGRAM PERFORMANCE

These are the measures needed by chief administrative officers to judge the Department's ability to meet highway program goals and other standards.

Measure II-1: Interstate Highway System Serviceability (Sufficiency) and Need

DEFINITION: These are measures to judge improvement, deterioration, or "no change" in the overall condition and serviceability of the Interstate Highway System.

MEASUREMENT: (a) Based on annual assessments, determine the year-to-year changes in the number of miles and the number of interchanges that do not meet state design, mobility, safety, and pavement condition standards.

(b) Based on the same annual assessments, determine the year-to-year change in the estimated cost to reconstruct or rebuild those highways that do not meet the state standards.

Measure II-2: Serviceability (Sufficiency) and Needs of Primary and Secondary State Highways

DEFINITION: These are the measures to judge improvement, deterioration, or "no change" in the overall serviceability of the primary and secondary highway systems.

MEASUREMENT: (a) Based on biennial assessments, determine the changes in the average *serviceability (sufficiency) indices* for primary, as well as secondary, state highways.

(b) Based on the same biennial assessments, determine the changes in the number of *miles* of each highway system that are rated as "good to excellent," "fair," and "poor" (intolerable).

(c) Based on the same biennial assessments, determine the biennial changes in the estimated *costs* to reconstruct or rebuild those primary and secondary highways that are rated as "poor" (intolerable).

Measure II-3: Bridge Structural Sufficiency and Needs

DEFINITION: These are measures of the overall changes in the structural condition of all bridges on the state highway systems—Interstate, Other Primary, and Secondary—as well as the bridges of the city, county, and town road systems.

MEASUREMENT: (a) Based on annual or biennial assessments, determine the changes in the *number of bridges* on each system that meet and do not meet federal/state load carrying capacity standards.

(b) Based on the same assessments, determine the changes in the *estimated cost* to rehabilitate or replace those bridges of each system that do not meet federal/state load carrying capacity standards.

Measure II-4: Bridge Functional Sufficiency and Needs

DEFINITION: These are measures of the overall changes in the functional sufficiency of bridges on the state highway systems—Interstate, Other Primary, and Secondary—as well as the functional sufficiency of the bridges on the city, county, and town road systems.

MEASUREMENT: (a) Based on annual or biennial assessments of all bridges, determine the year-to-year changes in the number of bridges of each road system that meet and do not meet federal/state functional standards.

(b) Based on the same assessments of all bridges, determine the year-to-year changes in the *estimated costs* to rehabilitate or replace those bridges on each system that do not meet federal/state functional standards.

Measure II-5: Highway Pavement Condition

DEFINITION: These are measures of change in pavement structural condition and rideability for the several classifications of state highway—Interstate, Other Primary, and Secondary.

MEASUREMENT: Based on annual or biennial assessments, determine the changes in the number of miles of state highway in each system that are in “good-to-excellent,” “fair,” and “poor” ranges of pavement structural condition and rideability. Also compare with established goals for each class of highway. Depending on each state’s pavement management system, it may be appropriate to measure lane miles of pavement condition change.

Measure II-6: Highway Safety

DEFINITION: These are the measures to judge the effectiveness of the state’s overall highway safety program.

MEASUREMENT: (a) Compare monthly and year-to-date *traffic fatalities*, *traffic injuries*, and *total traffic accidents* with similar facts for the previous calendar year;

(b) Compare the state’s *traffic fatality rate* (traffic deaths per 100 million vehicle miles of travel) for the last calendar year with state goals, the national average, and with the traffic fatality rates of states of similar population, population density, climate, and topography; and

(c) Compare last year’s *20 highest accident locations* with similar data for each of the past 5 years.

Measure II-7: Congestion

DEFINITION: This is a measure of the Department’s ability to improve mobility at congestion “hot spots” on the state highway system.

MEASUREMENT: Determine the number of intersections or sections of state highway that have been removed—as a direct result of construction, traffic engineering, or other improvement—from each of the 5 previous years’ annual list of the 20 most congested intersections or sections. Express number of improvements accom-

plished as percentages of each year’s 20 most congested intersections or sections.

Measure II-8: Long-Range Program Goals

DEFINITION: These are measures of the Department’s ability to meet established goals for the following:

- Interstate Highway System rehabilitation and reconstruction,
- Other Primary Highway System rehabilitation and reconstruction,
- Secondary Highway System rehabilitation and reconstruction,
- Bridge rehabilitation and replacement,
- Resurfacing, and
- Other goals, i.e., spot improvements, safety, and capacity.

MEASUREMENT: Determine the *miles of highway* and the *number of bridges* let to construction contract in the past year. Express as percentages of the goals for the year and percentages of multiyear plans or goals.

Measure II-9: Federal-Aid Funds

DEFINITION: These are measures of the Department’s ability to obligate federal-aid highway funds.

MEASUREMENT: (a) Determine the proportion of total annual federal obligational authority committed to state and local government use during each of the last 5 federal fiscal years.

(b) Determine the dollar volume and proportion of total annual federal obligational authority committed to state and local government use during each month of the current federal fiscal year and for the corresponding months of the previous year.

NOTE: The (a) measurements will exceed 100 percent for most states. Nevertheless, these are important facts for the chief administrative officer to judge program performance.

Measure II-10: State-Aid Funds

DEFINITION: These are the measures of the Department’s and local governments’ ability to obligate annual state-aid appropriations.

MEASUREMENT: (a) Determine the proportion of the last fiscal year’s annual appropriation of state-aid funds that were obligated for (committed to) local road and bridge rehabilitation and replacement.

(b) Determine the dollar volume and proportion of the current year’s appropriation of state-aid funds that were committed to local government use in each of the months of the current fiscal year. Compare with similar facts for the previous year.

NOTE: These are measures of the ability of the Department and local governments to work together to improve roads and streets under the jurisdiction of local governments. The research team observes that most of the problems rest on local governments’ ability to meet their commitments of resources.

Measure II-11: Preconstruction Project Development

DEFINITION: These are measures of the Department's overall efficiency in preconstruction project development.

MEASUREMENT: Determine the average proportion (and the range of proportions) of construction award cost for expenditures devoted to preconstruction planning, design, and plan preparation for all projects awarded to construction in the last fiscal year. Include all costs from either the date each project was officially programmed or from another suitable reference point that marks the commencement of preconstruction preparation. Compare the results with Department goals and with similar facts for other states. To compare the Department's and consultants' management of preconstruction project development, segregate the performance measures.

Measure II-12: Construction Management

DEFINITION: These are measures of the Department's ability to efficiently manage highway and bridge construction.

MEASUREMENT: Determine the proportion of final construction cost that was devoted to Department staff and consultant layout, inspection, and quality control of construction for all contracts *finalized* in the last fiscal year. Compare with Department goals and with similar facts for other states. To compare the Department's and consultants' management of construction, segregate the performance measures.

Measure II-13: Interstate Highway System Maintenance

DEFINITION: This is a measure of the Department's ability to economically maintain the Interstate Highway System.

MEASUREMENT: Determine the maintenance costs per lane mile of Interstate Highway for the last fiscal year and for the previous 4 years. Compare with Department goals and with similar facts for other states of similar climate, population density, and topography.

NOTE: If the maintenance costs are increasing, this may be an indicator of highway deterioration. Older pavements, subgrades, and shoulders, for example, require more maintenance than their newer counterparts. Furthermore, if maintenance costs are otherwise changing, such information may indicate changes in the level of maintenance service provided. Nevertheless, maintenance cost changes are important performance indicators.

Measure II-14: Maintenance of Other Primary Highways

DEFINITION: This is a measure of the Department's ability to economically maintain Other Primary Highways.

MEASUREMENT: Determine the maintenance costs per lane mile of Other Primary Highways for the last fiscal year and for the previous 4 years. Compare with Department goals and with similar facts for other states of similar climate, population density, and topography.

NOTE: Same as II-13.

Measure II-15: Maintenance of Secondary Highways

DEFINITION: This is a measure of the Department's ability to economically maintain Secondary Highways.

MEASUREMENT: Determine the maintenance costs per lane mile of Secondary Highways for the last fiscal year and for the previous 4 years. Compare with Department goals and with similar facts for other states of similar climate, population density, economic development, topography, and proportion of miles on the state highway system.

NOTE: Same as II-13.

Measure II-16: Construction Contract Cost

DEFINITION: These are measures of the Department's and its contractors' effectiveness in meeting cost targets.

MEASUREMENT: Determine the number and proportion of projects finalized in the last fiscal year whose costs were (a) less than 5 percent over total award costs and (b) more than 5 percent over award cost. Compare with Department goals.

NOTE: A high proportion of projects with final costs over 5 percent of award costs could also mean poor quality construction plans.

Measure II-17: Construction Contract Schedule

DEFINITION: These are indicators of the Department's and its contractors' effectiveness in meeting construction time targets.

MEASUREMENT: Determine the number and proportion of contracts finalized in the last fiscal year that (a) were completed within the scheduled time period, (b) required authorized time extensions, and (c) required added days due to delinquent contractor performance. Compare with Department goals.

Measure II-18: Preconstruction Cost Control

DEFINITION: These are measures of the Department's ability to accurately estimate improvement projects' costs as well as to control costs as the improvements move through preconstruction planning phases.

MEASUREMENT: Determine the difference between contract award costs and the initial programmed costs for each project let to contract in the last fiscal year. Sort the results according to the number of projects whose award costs were (a) within 10 percent of programmed costs and (b) 10 percent or more above programmed costs. Compare with Department goals.

Measure II-19: Contractor Payment Schedule

DEFINITION: This is a measure of the Department's efficiency in making payments to contractors.

MEASUREMENT: Determine the amount of delinquent interest payments made to contractors due to late payment of invoices during

the past fiscal year and each month of the current year. Compare with Department goals.

Measure II-20: Advertisement Schedule

DEFINITION: This is a measure of the Department's ability to meet planned advertisement schedules.

MEASUREMENT: Determine the proportion of projects that met the yearly planned advertisement schedule for the past 12 months. Compare with Department goals and with other states.

Measure II-21: Equipment

DEFINITION: This is a measure of the Department's ability to maintain its vehicle and equipment fleet.

MEASUREMENT: For each major class of equipment (i.e., automobiles, vans, and pick-up trucks; light trucks; heavy trucks; and special motorized equipment), determine (a) total equipment downtime and (b) total equipment usage both in terms of days and fractions of days for the last calendar year. To measure the serviceability of the Department's equipment fleet, express downtime as proportions of usage for each major class of equipment. Compare with Department goals.

Measure II-22: Cost

DEFINITION: These are measures to judge the overall cost-effectiveness of the highway program.

MEASUREMENT: (a) Compare the current total program costs with those of the previous 5, 10, and 20 years. Besides total program costs, compare current costs per vehicle mile of travel, per mile of highway, and per lane mile of highway. Use the annual composite construction cost indices as established by the Department or by the Federal Highway Administration to express costs in constant values.

(b) Compare total highway program expenditures and total expenditures per mile of travel, per mile of highway and per lane mile of highway with similar data for states of comparable population, population density, climate, topography, and proportion of road miles on the state highway system. Use data from previous fiscal year.

Measure II-23: Air Quality

DEFINITION: These are the measures for judging the ambient air quality in those regions that have not attained state and federal standards.

MEASUREMENT: Determine the annual progress or lack of progress that each region has made over the past 10 years in meeting carbon monoxide standards.

III. PUBLIC TRANSPORTATION PROGRAM-PERFORMANCE MEASURES

These are the measures needed by the chief administrative officers to judge the Department's ability, and the ability of

public transportation providers that are being assisted by state funds, to meet public transportation goals and other standards.

Measure III-1: Urban Service

DEFINITION: These are measures of the extent and effectiveness of the services provided by state and federal government supported public transportation operators.

MEASUREMENT: Determine the following:

- (a) the annual miles of commuter rail, heavy rail, light rail, bus, and demand-responsive services per unit of urban population for each public transportation operator and each urban area;
- (b) the annual revenue passengers per mile of service for each type of service and for each public transportation operator;
- (c) the proportions of peak-period trips in each urban area that are transported by public transportation; and
- (d) the proportions of peak-period trips in each urban area that are transported by public transportation to central business districts.

Compare with state/urban area goals and with national averages.

Measure III-2: Urban Operating Cost-Effectiveness

DEFINITION: These are measures of the cost-effectiveness of the services provided by state and federal government supported urban public transportation operators.

MEASUREMENT: Determine the following:

- (a) the total annual operating cost of the commuter rail, heavy rail, light rail, bus, and demand-responsive services provided by each public transportation operator;
- (b) the total annual operating cost per mile of service and per revenue passenger for each type of service and for each public transportation operator;
- (c) the total annual state and federal operating assistance per mile of service and per revenue passenger for each type of service and for each public transportation operator; and
- (d) the total annual fare and other operating revenue per mile of service and per revenue passenger for each type of service and for each public transportation operator.

Compare (a) through (d) results with state/urban goals and with national averages.

Measure III-3: Rural and Community Service and Operating Cost-Effectiveness

DEFINITION: These are measures of the extent and cost-effectiveness of the rural and community public transportation services provided by state and federal government supported operators.

MEASUREMENT: Determine annual statewide totals for (a) miles of regular and demand-responsive services, (b) revenue passengers, (c) revenue passengers per mile of service, (d) annual fare revenue, (e) state and federal operating assistance, (f) average fare [(d)

divided by (c)], and (g) average operating assistance per revenue passenger.

Compare with statewide goals and with national averages.

Measure III-4: Capital Cost-Effectiveness

DEFINITION: These are measures for judging the cost-effectiveness of state and federal grants for public transportation capital improvements.

MEASUREMENT: Determine capital expenditures per revenue passenger for each of the past 10 years. Segregate into urban and rural measures and compare with urban and rural goals and with national averages.

IV. MEASURES OF MOTOR VEHICLE PROGRAM PERFORMANCE

These are the measures needed by the chief administrative officer to judge the ability of the Department to meet driver and motor vehicle licensing goals and other standards of performance.

Measure IV-1: Service

DEFINITION: These are the measures for judging the service provided to the public by motor vehicle division employees.

MEASUREMENT: (a) Determine the average processing time for the issuance of 1) vehicle title changes, 2) renewal of drivers' licenses, and 3) new drivers' licenses.

(b) Determine the *quality of service* in terms of average numbers and percentages of monthly processing errors associated with the issuance of titles and licenses [(a) 1) through 3) above].

Compare (a) and (b) with Division goals and with the experiences of other states.

Measure IV-2: Cost

DEFINITION: These are the measures for judging the cost effectiveness of Motor Vehicle program service.

MEASUREMENT: Determine the average annual cost of each of the transactions listed in IV-1. Compare with Division goals and with the experiences of other states.

V. OTHER TRANSPORTATION PROGRAMS

There may be other measures that chief administrative officers need to judge the performance of railroad, airport, port, ferry, and ancillary programs. For each program, compare last year's costs and services with costs and services for the previous 5 years. Also compare last year's costs and services with established Department goals as well as with comparable services provided by other states or other transportation providers being assisted financially by the state.

CHAPTER 5

CONCLUSIONS

The following conclusions are based on the results of this research and the research team's long association with transportation program management:

1. Program-performance measures will become increasingly important tools for legislators and citizens in judging the performance of public programs and in holding officials accountable for the efficiency and effectiveness of their programs.
 2. The nation's highway and transportation officials will lead the way for other state officials in the use of performance measures, as they have in the adoption of computer technology and many other productivity enhancements.
 3. Much of the information needed to establish systems of transportation program-performance measures—more commonly referred to as executive information systems (EIS)—are readily available. However, in order to make full use of program-performance measuring systems, state highway and transportation departments need to devote more resources to monitoring the physical condition and the services provided by state supported transportation systems.
 4. Program goals are needed as benchmarks for measuring program performance.
 5. All state highway or transportation programs differ in mission, scope, and goals. Therefore, transportation program-performance measuring systems have to be tailored to each state's needs.
 6. Chief administrative officers can use state-to-state comparisons of program performance in decisions on budgets and staffing. However, when comparing the performance of one state highway program with another, it is important to select states of similar geography, topography, population density, climate, and state highway system characteristics, and then to use the information judiciously.
 7. Beyond the use of performance measures to judge overall program performance, there are other opportunities to use performance measures to improve the management of the many processes needed to accomplish state transportation program missions.
 8. Newcomers to transportation program management will find the information in Chapter 3, "Needs of the New Chief Administrative Officer," useful in orienting themselves to their new role.
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APPENDIX A

SURVEY ASSESSMENT PARTICIPANTS

The names and affiliations of the survey assessment participants have been included in the Acknowledgments of this report.

APPENDIX B

SURVEY SUMMARY

The following pages replicate the survey instructions and the survey forms that were mailed in November 1991 to the chief administrative officers of the transportation departments of the 50 states, the District of Columbia, Puerto Rico, and the 10 Canadian Provinces. A total of 51 questionnaires were completed and returned.

The researchers have indicated the survey results by inserting the numbers of respondents that checked each of the survey form boxes.

NCHRP 20-24(6)A

Performance Measures
For
State Highway and Transportation Agencies

SURVEY BACKGROUND INFORMATION AND INSTRUCTIONS

This survey of state highway and transportation officials is part of the AASHTO-sponsored National Cooperative Highway Research Program that is administered by the Transportation Research Board. The research is being coordinated by the Highway Users Federation of Washington, DC.

The two-part questionnaire is based on surveys the Highway Users Federation has made in a series of state transportation program management reviews carried out since 1984.

We have tried to establish objective survey formats, ones that will yield clearcut answers. Ample space is provided for your comments on both the program performance measures and internal management factors that are set forth as examples. Ample space is also provided for you to add performance measures and management factors.

There are two main parts to the questionnaire. Part I centers on measures to evaluate transportation program results, while Part II centers on the critical management factors needed by the chief administrative officers of state transportation programs.

Part I

The objective of Part I is to gain national consensus on a set of program performance measures for evaluating the effectiveness and efficiency of state transportation programs. In plain language, we would like to arrive at practical guidelines for accounting to the traveling public on "how much bang they are getting for their bucks".

Part I focuses on the means used by -- or could be used by -- the top management team of the state transportation department (as well as the transportation commission, the governor, state legislators, and other interested parties) to gauge whether or not progress is being made in improving the physical condition of the state transportation system and the service it provides to the public. Some of the measures are oriented toward evaluating program efficiency and/or cost effectiveness.

We recognize that in many cases your organization's measures may be implicit, rather than clearly spelled out. However, we

ask that you give us your best thoughts on how the program should be judged in terms of goals and objectives, if you could start with a clean slate.

There are two aspects to Part I, A) Evaluating Progress Over Time (which could also be referred to as, "Meeting Established Goals"), and B) Comparing With Other States. In judging the utility of comparisons with other states, it is axiomatic that such comparisons can only be made within wide value ranges and can only be made with states of similar program characteristics, geography, climate and population density.

The two aspects of Part I (A and B) are contained within the same questionnaire. Therefore, we ask that you read each program performance measure listed and evaluate its applicability in judging the performance of state transportation programs -- over time (A), as well as in comparison with other states' programs (B).

Four choices are available to you for the (A) evaluation, as follows: "currently in use", "not used but desirable", "not feasible", and "irrelevant". Three choices are available to you for the (B) evaluation, as follows: "desirable", "not feasible" and "irrelevant". Please check one of the four (A) evaluation boxes as well as one of the three (B) evaluation boxes. Also if the "not feasible" or "irrelevant" boxes are checked, please indicate your reasons in the comment space provided.

Space is available at the end of each of the nine performance measure categories (ie. State Highway Program Costs) for suggested additions. Space is also available at the end of Survey I for your general comments about the usefulness of performance measures in monitoring state transportation programs. We look forward to your suggested additions and comments.

We recognize the constraints within which you operate and that these will influence your responses. We also recognize that some measures are not universally applicable to all states. However, we ask that you give us your views on how state transportation programs should be evaluated in terms of quantifiable performance measures.

Part II

Besides the measures for evaluating program performance, the Highway Users Federation and the NCHRP Panel also postulate that there are a number of internal management factors needed by the top management team to gauge whether or not state transportation programs are being carried out in a satisfactory manner or whether top management corrective action is required. Like Part I, the objective of Part II is to find consensus among state transportation officials on a set of internal management factors.

For each of the internal management factors listed in Part II, we ask that you check one of the four possible responses, as follows: "currently in use", "not used but desirable", "not feasible" and "irrelevant". As in Part I, we ask that you comment on your reasoning for citing the "not feasible" and "irrelevant" choices. Space is available for your comments on each of the cited internal management factors.

We also ask that you add to the list of internal management factors. Immediately after the example set of internal management factors, there is space available in Part II for your additions. Your suggestions for improving upon the terminology -- "internal management factors" -- would also be appreciated.

Finally, we ask for your overall comments about the use of internal management factors by the top management team in monitoring the administration of the state transportation program.

Relationship With Management Information Systems. We recognize that some states have adopted a management information system and your experience in both developing and employing such a system is important to this research project. We ask that you share this knowledge in Part II of this questionnaire.

If a guidebook or manual has been developed to assist in the employment of your management information system, we would appreciate receiving a copy of your material, or appropriate extracts. Please enclose this with the returned questionnaire.

Objective: A Resume Of Information. It should not be inferred from this survey that either the Highway Users Federation or the Transportation Research Board is promoting rigid nationwide conformity in the management of state transportation programs. In contrast, the objective of the research is to give state transportation program managers a resume of information that might be of assistance in improving program efficiency and effectiveness in an era of increasingly tight resources.

The Schedule

We ask that the completed survey form be returned by December 13, 1991.

Your survey responses will be carefully evaluated and summarized by the Highway Users Federation, the NCHRP Panel and a team of current and former chief administrative officers during the remaining weeks of 1991 and early in 1992. A report of the survey findings and our analysis will be published in 1992.

Returns

Please return the completed questionnaire to:

Marshall Reed, PE, Principal Investigator
Highway Users Federation
1776 Massachusetts Avenue
Washington, DC 20036

Survey Questions

We recognize that there will be questions about the survey. Please contact Marshall Reed at 202 857 1200.

Thank you.

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STATE

PERFORMANCE MEASURES QUESTIONNAIRE, NCHRP 20-24(6)A

Part I: Evaluating State Transportation Program Performance

Instructions: Please check the statements that best describe your views on the usefulness of each of the following measures in evaluating program performance:

A. over time (5, 10, 20 year or longer periods), and

B. In comparison with other states of comparable population density, climate, geography, and terrain.

If you judge a measure to be "not feasible" or "irrelevant", we need your reasoning in the space for comments.

At the end of each category of program performance measure there is space for you to add measures that you deem were left out, but yet could be important for judging the efficiency and effectiveness of state transportation programs.

At the end of Part I there is space for you to make general observations about the usefulness and applicability of program performance measures.

A. The Highway System Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
(1) Lane-miles of state highway Comments:	40	1	1	9	35	2	14
(2) Proportion of statewide motor vehicle travel served by state highway system. Comments:	33	9	1	8	26	4	11
(3) Proportion of urban travel served by state highways. Comments:	24	15	3	9	35	3	13
(4) Miles of high-capacity highways (four- or more lane, divided highways). Comments:	29	8	0	14	29	1	21
(5) Miles of high-capacity highways per unit of state population (10,000 people). Comments:	7	20	1	23	24	3	24
(6) Miles of urban high-capacity highways per unit of urban population (10,000 people). Comments:	9	22	0	20	29	1	21

A. The Highway System (cont'd) Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
(7) Lane-miles of urban highways per unit of urban population (per 10,000 people). Comments:	8	27	0	16	34	1	16
(8) Mobility (miles of highway by level of service or v/c). Comments:	34	14	2	1	44	3	4
(9) Proportion of statewide, heavy truck travel served by high-capacity highways. Comments:	19	21	2	9	37	2	12
Other suggested measures for evaluating state highway system performance:							

B. Highway Program Costs Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
(10) Proportion of total state budget devoted to state highway (or transportation) program. Comments:	25	10	1	15	34	1	16
(11) State highway program expenditure trends in constant dollars. Comments:	38	9	0	4	43	1	7
(12) Annual state highway program expenditures per vehicle mile of vehicle travel on the state highway system. Comments:	11	30	1	9	40	2	9
(13) Annual state highway program expenditures per unit of state population. Comments:	11	28	0	12	38	1	2
Other suggested measures for evaluating highway program costs:							

C. Human Resources Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Not Relevant	Desireable	Not Feasible	Not Relevant
(14) State highway employees per lane-mile of state highway. Comments:	16	18	3	14	34	1	16
(15) Numbers of state highway maintenance employees (assigned to field crews) per lane-mile of state highway. Comments:	26	16	2	7	40	1	10
(16) Numbers of state highway construction management employees per million dollars of construction underway. Comments:	19	23	3	6	40	2	9
(17) Proportion of annual state highway (or transportation) program expenditures devoted to employee personal services costs (including fringe benefits). Comments:	19	17	3	11	33	5	12
(18) Proportion of annual state highway (or transportation) program expenditures for contracted personal services. Comments:	20	21	1	9	35	4	12
(19) Numbers of Registered Professional Engineers. Comments:	29	12	1	9	37	2	12
(20) Number of Engineers-in-Training. Comments:	28	11	0	12	35	1	15
(21) Average age of department employees. Comments:	23	11	2	15	30	1	20
Other suggested human resource performance measures:							

D. Highway Needs and Conditions Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Not Relevant	Desireable	Not Feasible	Not Relevant
(22) Sufficiency (miles of highway by sufficiency rating). Comments:	34	13	2	2	38	4	9
(23) Measured Needs (engineering evaluations and summaries of the miles of deficient highways and the dollar needed to bring the deficient highways to tolerable standards). Comments:	38	9	1	3	37	6	9
(24) Interstate Highway System rehabilitation needs (miles of Interstate Highways that do not need current design standards). Comments:	34	12	0	5	39	1	11
(25) Bridge conditions (number of bridges by condition rating category). Comments:	48	3	0	0	45	0	7
(26) Pavement conditions (miles of highway in two or more condition rating categories, i.e. good, fair, poor). Comments:	47	4	0	0	41	2	8
(27) Pavement type (miles of highway in two or more roadway surface categories). Comments:	42	4	1	4	35	0	16
(28) Shoulders (miles of highway in two or more categories of shoulder width and/or surface). Comments:	33	11	0	7	34	1	16
Other suggested measures for evaluating state highway system needs and conditions:							

E. Highway Improvements Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
(25) Annual miles of state highways resurfaced with over 1 inch of bituminous material. Comments:	35	9	0	7	33	2	16
(30) Annual miles of state highways resurfaced with less than 1 inch of bituminous material. Comments:	21	9	3	18	23	3	25
(31) Annual miles of state highways chip-sealed (armour-coated). Comments:	31	9	1	10	27	2	22
(32) Annual proportion of the state highway system resurfaced and re-sealed each year. Comments:	36	10	0	5	40	1	10
(33) Annual miles of new or re-constructed state highways. Comments:	38	7	1	4	37	3	10
(34) Current value of state highway vehicles and field equipment. Comments:	27	7	2	14	23	2	25
(35) The proportion of the current value of state highway vehicles and equipment that is spent annually on equipment replacement (average annual expenditures). Comments:	25	13	0	12	30	2	18
Other suggested measures for evaluating highway improvement program performances:							

F. Highway Safety and Risk Management Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
(36) Annual traffic accidents, injuries, and/or deaths on state highway system. Comments:	48	0	1	2	41	4	6
(37) State highway system traffic fatality rates (deaths per 100 million vehicle miles of state highway system travel). Comments:	48	3	0	0	49	2	0
(38) State highway system traffic accident and/or injury rates. Comments:	48	3	0	0	48	2	1
(39) Risk management (annual tort liability judgments in dollars). Comments:	17	19	6	9	29	4	17
Other suggested measures for evaluating highway safety and risk management performance:							

G. Mass Transit Service Use, and Cost Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
(40) Annual transit patronage (statewide, bus and rail). Comments:	40	7	0	4	37	2	12
(41) Annual transit expenditures (state and federal funds, only, bus and rail). Comments:	41	3	0	7	36	4	11
(42) Annual transit program expenditures per annual transit patron (bus and rail). Comments:	28	18	0	5	39	4	8
(43) Proportion of total urban trips (average daily) using bus/rail transit systems. Comments:	18	25	3	5	35	7	9

G. Mass Transit Service Use, and Cost (cont'd) Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
	(44) Daily route-miles of urban bus service.	26	13	3	9	35	2
Comments:							
(45) Daily bus transit patrons per route-mile of bus service.	26	16	2	7	39	2	10
Comments:							
(46) Daily rail transit patrons per route-mile of rail transit service.	19	11	3	17	27	5	18
Comments:							
Other suggested measures of mass transit program performance:							

H. Air Transportation Measures of Performance	A. Evaluating Progress Over Time				B. Comparing w/ Other States		
	Currently In Use	Desireable	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
	(47) Annual state and federal expenditures on airports.	35	7	1	7	36	2
Comments:							
(48) Annual state and federal expenditures on air carrier airports.	31	7	1	11	32	1	16
Comments:							
(49) Annual airport expenditures per air passenger enplanement.	18	19	2	11	31	1	17
Comments:							
Other suggested measures of air transportation program performance:							

I. External Factors Measures of Performance	(a) Evaluating Progress Over Time				(b) Comparing w/ Other States		
	Currently In Use	Not Used But Not	Not Feasible	Irrelevant	Desireable	Not Feasible	Irrelevant
	(50) Letters of Appreciation	24	14	4	8	10	10
Comments:							
(51) Complaint Letters	25	13	6	7	9	12	27
Comments:							
(53) Positive Editorials	25	13	5	8	9	11	28
Comments:							
(54) Negative Editorials	22	15	6	8	8	12	28
Comments:							

Other comments on the use of performance measures to evaluate the state highway and/or transportation program:

STATE
PERFORMANCE MEASURES QUESTIONNAIRE, NCHRP 20-24(6)A

Part II. Evaluating Internal Management Factors

Instructions:

Besides the Program Performance Measures, there are a number of Internal Management factors needed by the top management team to gauge whether or not the state transportation program is being carried out efficiently and effectively. The Internal Management Factors are selected facts about program management that are needed on at least a monthly basis to: a) ensure the top management team that all is well, or b) indicate to top management that remedial action is required to correct a problem or problems.

Like Part I, the objective of Part II is a listing of Internal Management Factors that - 1) are currently in use by the top management team in program management, or 2) are viewed by the top management team as desirable information for use in program management, 3) are not feasible for use in program management, or 4) are irrelevant to program management from the perspective of the top management team. Some factors are listed on the survey form and we ask that you judge their usefulness. We also ask that you add other important Internal Management Factors that are not included in the questionnaire, but that you deem are essential for efficient and effective internal program management.

Internal Management Factors	Currently In Use	Desirable	Not Feasible	Irrelevant
A. Financial				
(1) Actual vs. Projected Revenues	46	2	0	3
Comments:				
(2) Actual vs. Budgeted Expenditures	50	1	0	0
Comments:				
(3) Federal-Aid Encumbrances vs. Obligation Authority	43	1	0	6
Comments:				
(4) Cash On Hand	43	1	1	5
Comments:				
(5) Other Financial Management Factors (Please list):				

Internal Management Factors	Currently In Use	Desirable	Not Feasible	Irrelevant
B. Improvement Program				
(1) Planned vs. Current (Actual) Award Schedule	45	4	0	1
Comments:				
(2) Planned vs. Current Project Estimates	44	6	0	0
Comments:				
(3) Engineers' Estimate vs. Bid Prices	48	1	1	0
Comments:				
(4) Awards vs. Final Contract Amount	40	9	0	1
Comments:				
(5) Reliance on Consultants - Project Development	43	4	2	1
Comments:				
(6) Reliance on Consultants - Construction Management	37	6	2	5
Comments:				
(7) Other Improvement Program Management Factors (Please list):				

Internal Management Factors	Currently In Use	Desirable	Not Feasible	Irrelevant
C. Human Resources				
(1) Vacant Positions	43	3	0	4
Comments:				
(2) Vacant Management Positions	41	5	1	3
Comments:				

Internal Management Factors	Currently In Use	Desireable	No. Feasible	Irrelevant
C. Human Resources (cont'd)				
(3) Turnover Rates	38	13	0	0
Comments:				
(4) Absentee Rates	36	14	1	0
Comments:				
(5) Overtime	26	20	2	3
Comments:				
(6) Compensatory Time	46	4	1	0
Comments:				
(7) Employee Lost-time Accidents	39	7	2	2
Comments:				
(8) Meeting Equal Employment Opportunities Objectives	48	0	0	2
Comments:				
(9) Other Human Resources Management Factors:				

Internal Management Factors	Currently In Use	Desireable	No. Feasible	Irrelevant
D. Other				
(1) Equipment Downtime	37	10	1	2
Comments:				
(2) Tort Liability Claims	36	9	1	4
Comments:				

(3) Other Internal Management Factors (Please list):

Other comments on the use of internal management factors by the top management team of the state highway and/or transportation program.

Exploring Methodologies for Comparing State Highway Performance

Supplement to
NCHRP Report 357

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Prepared for
National Cooperative Highway Research Program
Transportation Research Board
National Research Council

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EXECUTIVE SUMMARY

The challenge associated with measuring performance is complex, often subjective and controversial, and requires careful and prudent forethought. Such is the case in determining the feasibility of making valid comparisons of the performance of state highway systems and evaluation of methodologies used or proposed for use in making such comparisons. This report states the finding and conclusions of a study undertaken to: 1) assess the current practice in comparative program/system evaluation; 2) explore the feasibility of making comparison of the performance of state highway systems; 3) define the characteristics of methodologies used and proposed for use in making such comparison; and, 4) propose appropriate actions.

A review of the literature on the topic of program performance and comparative analyses suggested several noteworthy observations. Concerning highway program performance studies; the states and the FHWA collect large volumes of statistics annually. FHWA must rely upon the accuracy of the data submitted, and they do take steps to maintain as high a degree of quality control as possible. However, based upon the review of the studies available for this project, there are a number of precautions that must be observed when using these data. They include:

- inconsistencies in the methods of reporting;
- differences in the assumptions that are used in gathering and reporting;
- the absence of qualifying factors, such as urban congestion, costs of labor and materials, sources of funding, use of funding, environmental concerns, demographic conditions, geography, topography, etc.; and
- inconsistencies in the analysis methodologies

There is clear agreement that the inconsistencies in the available data make it very difficult to compare states based upon those data. However, there is also agreement that it is desirable that appropriate measures of performance be established that would allow for a comparative "peer" analysis of state highway programs.

Several studies used to assess various aspects of the performance of state transportation programs were selected for review. Although each dealt with various aspects of program performance, each was also quite different in its motivation and in the approach used to achieve the stated objectives.

The studies illustrated the following relative to their potential for making state comparisons:

1. The data used for such purposes must be consistent in quality and appropriateness for the objectives to be served;
2. The analysis methodology must be appropriate and consistent if state-by-state comparisons are to be made;
3. External, often uncontrollable factors make it difficult and often inappropriate for the comparison of states; and
4. The inappropriate comparisons of state data can lead to inaccurate conclusions and be counterproductive in their misuse.

Throughout this report we have alluded to the desirability of establishing program performance measures.

An annotated bibliography of pertinent literature is provided in an appendix and is summarized in the report for highway, transportation, and non-transportation cases. Of note were examples of performance measures, system comparisons, and the issues associated with the use or non-use of particular factors. A conceptual framework for program assessment is presented with more focus and description given to three major elements of an assessment methodology: performance measures, input variable, and external factors.

The report concludes with a series of observations which provide direction to conducting any comparisons of state highway performance. It is concluded that the performance evaluation of a state's highway program is, and will continue to be, an important component of highway management. However, our review has made it clear that a comparative evaluation of state highway program performance is: 1) an extremely complex activity that must take into account the many external factors that could influence the value of the input or output variables or the relationship between the two; 2) dependent upon the underlying assumption of the cause-effect relationship that is common to all of the program being evaluated; and 3) dependent upon several characteristics of the data themselves that make consistent and reliable comparative estimates very difficult to do.

In summary, we did not find any report in the literature that provided a sufficiently complete framework and accounting of the above considerations that, in our opinion, produced pertinent or constructive comparative evaluation.

CHAPTER 1

INTRODUCTION

"Whether the goal is defending the nation or immunizing children against disease, government officials and the public need to know how well government is accomplishing its intended objectives. Assessing government accomplishments requires measuring...program performance. Though the size and complexity of the government make it difficult, developing effective performance measurement systems is clearly possible."

—Government Accounting Office

Measuring program performance regardless of the mission or topic is complex, often controversial, and requires careful and prudent forethought. Assessing performance is a common occurrence in all aspects of human endeavor. The ordering of performance of athletic teams, for example, may be considered more direct and simpler than the ordering of an undergraduate academic program among universities; yet one can readily identify the annual controversy which springs from the annual or periodic arrangement of such orderings. The methodological approach, the selection of the performance measures, the relative importance of the measures, the quality of the data, and the integration of the results are often issues subject to challenge. With due recognition of the issues and risks involved, the goal remains noteworthy. The importance of the goal is not in the relative ordering of competing or comparable units but in seeking enhanced offering, productivity or similar priorities. Therefore, the selection of the approach must be such that the result yield insights into opportunities and strategies for improvement.

This report describes an effort undertaken as a result of Policy Resolution PR-25-92 approved by the American Association of State Highway and Transportation Officials Board of Directors on October 4, 1992. The action requested the "Transportation Research Board to address the issue associated with state highway performance comparisons." This effort, having been prompted by a recently released report, was proposed to determine the feasibility of making valid comparisons of the performance of state highway systems and an evaluation of methodology used and proposed for use in making such comparisons. The charge for the proposed study recognized the current effort underway by the Highway Users Federations entitled "Measuring State Transportation Program Performance" (NCHRP Project 20-24(6)A).

1.1. Objectives of the Study

Recognizing the activities currently underway or recently completed and the essence of the AASHTO Policy Resolution, the objectives of the study reflected in this report were four (4) fold:

- 1) To assess current practice in comparative program/system evaluation;
- 2) To explore the feasibility of making valid comparisons of the performance of state highway systems;
- 3) To define the characteristics of methodologies used and proposed for use in making such comparison; and

- 4) To propose actions which are deemed appropriate and which stem from this analysis.

1.2 Study Scope

The scope of work included the identification of relevant experiences in fields other than transportation where rank orderings were developed. The synthesis of the literature found and reviewed is reported in Chapter 2, with more complete information on the key documents found in Appendix B. More citations obtained during a broader sweep of the computerized TRIS files are given in Appendix A. This facilitated the search process by providing direction to resources beyond readily retrieved sources. Contacts and approaches were made to non-transportation organizations and fields of endeavor to explore pertinent activities and literature such as in health programs, social sciences, education and World Bank programs.

Particular attention was given to examples of the use of specific indications of performance and their use in monitoring performance or in other approaches to accountability. This related to highway and non-highway cases. Of particular importance were instances where highway system performance ratings and rankings had been used or might be used, and if so, by whom.

Similarly, attention was directed to identifying those factors such as bias or variation among individual states to include highway needs, system utilization, monetary costs, growth rates, climatic variation, topography, urban/rural balance, legislative policies, mileage and functional classification of highways under state control. Chapter 3 presents a review of the approach found to compare performance of various activities.

Lastly, the scope included the search for alternative applications for an overall ranking of each state highway system or indication of performance in specific activity such as the six management system mandated in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Chapter 4 suggests a means of characterizing a good highway performance assessment.

The remaining chapter in this report summarizes the findings of the study.

CHAPTER 2

SYNTHESIS OF LITERATURE AND REPORTS

2.1 Introduction

This chapter summarizes the results of a comprehensive assessment of recent studies, within the past five years, which have attempted to assess the performance of several major programs affecting the citizens of the United States. The programs are in the areas of transportation, education, health and other social service. For a variety of reasons described below, aspects of state highway and transportation programs have been the subject of numerous studies of this nature. Given the limited time available for this report, every effort was made to include all existing sources of information that were readily available. They were as follows:

For Highways:

- Transportation Research Information Service (TRIS) provided by the National Academy of Sciences;
- Contacts through the American Association of State Highway and Transportation Officials (AASHTO), its Standing Committee on Planning (SCOP);
- Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) reports to Congress;
- The Highway Users Federation (HUF); and
- Other sources.

For Education:

The U.S. News and World Report annual survey of higher education

For Health/Social Services:

A list of papers in this area can be found in Appendix A.

Appendix B summarizes each of the reports that were used for this study.

2.2 Summary of Sources of Information

2.2.1 Transportation

The survey of the sources of information described above resulted in the following:

1. Reports Through TRIS
This search did not uncover any reports on the topic covered in this analysis.

2. Reports From AASHTO/SCOP
This provided an extensive number of reports, as shown below. (Each is summarized in Appendix B):

States That Submitted Relevant Reports

- | | |
|---------------|---------------|
| 1. Alaska | 8. Nebraska |
| 2. Arkansas | 9. New Jersey |
| 3. California | 10. Oklahoma |
| 4. Idaho | 11. Oregon |
| 5. Kansas | 12. Texas |
| 6. Maryland | 13. Utah |
| 7. Minnesota | 14. Vermont |

States Reporting There Were No Relevant Reports

- | | |
|----------------|------------------|
| 1. Florida | 6. Pennsylvania |
| 2. Hawaii | 7. Tennessee |
| 3. Louisiana | 8. West Virginia |
| 4. Mississippi | 9. Washington |
| 5. Missouri | |

We assume that those states which did not respond do not have studies relevant to this report.

Highway Users Federation

The HUF has completed more than a dozen projects over the past several years for the purpose of analyzing the management and operations of State Highway and Transportation Agencies. Many of the individual state reports are similar in their methodology and analyses. Consequently, although all that we could obtain were reviewed, only one - for New Hampshire, is summarized in this report.

In addition to the individual state reports, we also reviewed the HUF's recently completed national study under contract to the National Cooperative Highway Research Program (NCHRP) titled: "Measuring State Transportation Program Performance," Final Report, November 1992.

Other Sources

A study was recently published by the University of North Carolina titled: "Resources vs. Results: Comparative Performances of State Highway Systems; 1984-1990," July 1992. It is included in our analysis.

2.2.2 Program Evaluation

The relative performance effectiveness of state highway programs falls into the general category of program evaluation. A great deal of literature has been written on the different approaches that can be used to undertake an assessment of an individual

program (e.g., mental health, public welfare, enforcement, job training). Less has been written on how to conduct a comparative assessment of programs that are not under a single policy or jurisdictional responsibility (e.g., comparative performance assessments of highway programs). A literature review was conducted of both scholarly works on program evaluation and of examples of program assessments. The Urban Institute was contacted to determine whether any studies of urban programs were available. In general, the literature does provide some theoretical insights into the most appropriate experimental design for conducting such an assessment, but again there were few instances in which the performance of 50 individual state programs were compared to each other. Another type of performance assessment, similar in intent to program evaluation, which is designed to compare the effectiveness of different alternatives, is the cost effectiveness approach used in the Federal Transit Administration's Alternatives Analysis process. This process was also included in this literature search.

2.2.3 Organizational Studies

Another body of literature considered relevant to this study was the area of evaluating organizational performance. Once again, this literature does not usually focus on comparative assessments of organizations across the country, but instead examines how one can establish a valid cause-effect relationship between organizational resources consumed and the eventual performance of the organization. Again, a literature search was conducted of this approach to program evaluation. Several studies carried out in California in the late 1970's on transit system performance as it related to important organizational resource characteristics were found to have relevance to this effort. Other literature found to be important in this area included works on organization environment and productivity.

2.3 Synthesis of Highway Reports

2.3.1 Purpose of State DOT Evaluations

All State Departments of Highways and Transportation (hereafter referred to as State DOT's) periodically conduct internal reviews of their operations. As alluded to above, and as summarized below, some states also request outside organizations to do an independent assessment of their operations. The results are used to critically evaluate and eventually improve the overall efficiency of the organization.

One method often used in these evaluations is to compare certain key program elements of one state to those of other states in order to compare program approaches and results. The data are usually obtained from FHWA statistics. Such information can also be used to help assess a state's program and its operations.

In the following discussion we summarize the methodologies used; the criteria used to analyze various program elements; the application of the results to individual state programs; and the potential application of such analyses in comparing one state to another.

2.3.2 Methodologies Used

The reports received from State DOT's and the other sources available fall into the following four categories of "methodologies":

- A. Analyses undertaken by the HUF; our review has included Alaska, Idaho, New Hampshire, Oklahoma, Oregon and South Carolina. In addition, we have included the recently completed national analysis by the HUF for the NCHRP.
- B. Analyses undertaken by a state to evaluate state-by-state statistics obtained from the Federal Highway Administration (FHWA). Our review included several states.
- C. Special purpose individual state analyses undertaken by the state, but conducted by an outside organization; our review includes California, Kansas, Nebraska, New Jersey, Texas, and Utah.
- D. State comparative analyses have included two studies.

The NCHRP study undertaken by the HUF and a study by a UNC/Charlotte research team.

The following summarizes each of the above categories of methodologies.

2.3.2.1 The HUF State Studies

1. Approach Used

The HUF has been involved in the analysis of state DOT programs for many years. During the past decade they have been invited by a dozen or more states to undertake these studies. The purpose of each is to evaluate the effectiveness of the state's highway program in meeting its citizens' needs for safety, service and cost effective transportation now and in the future. Each study typically covers many management, financial, highway needs, geographic, demographic, environmental, program performance and productivity issues.

The studies always involve detailed interviews with key members of the State DOT, State Legislature and various highway user groups. Studies and reports provided by the state are gathered and analyzed. The studies also typically obtain data from "peer" states to compare various highway performance measures. Each study always points to the social, environmental, demographic, financial and other unique characteristics of each state when making peer reviews.

The studies always result in a detailed set of recommendations to be used by the state to improve efficiency and productivity. Each study also identifies the constraints and barriers that must be considered in order to achieve the desired improvements.

2. Comments

The HUF reports are used extensively by the states who request them to guide them in modifying and improving their programs. Each report is very detailed in developing specific recommendations.

The state peer reviews are of particular relevance to this report. The HUF takes great care to point out that, although the comparative state-by-state statistics are of interest, they cannot be used to judge the effectiveness

or efficiency of a particular state. Comparisons between states may not be relevant because there are many significant demographic, geographic, financial, social and other factors that make each state unique. This is true even though the HUF carefully selects "peer" states that exhibit similar characteristics.

2.3.2.2 Studies Based Upon FHWA Statistics

1. Approach Used

Each year the FHWA collects numerous statistics from each State DOT concerning state highway activities and programs. These data are published annually in a document titled: "Highway Statistics." Each edition contains detailed data covering among other information, motor fuel, motor vehicles, driver licensing, highway finance, and roadway extent, characteristics and performance. An individual state may be interested in where it stands relative to other states, but based upon a limited review of such reports the reasons for those differences are not analyzed.

2. Comments

The states that summarize these data cannot analyze the reasons why their "ranking" occurs without undertaking considerable additional analysis. It is assumed that the data required to undertake such an analysis are not available.

2.3.2.3 Special Purpose Individual State Reports

The group of studies identified in this category include California, Kansas, Nebraska, New Jersey, Texas, and Utah. (These reports are summarized in Appendix B.) They are particularly relevant to this study because of the depth to which they analyzed the reasons for their differences with "other peer states." They are each summarized below.

1. Approach Used: California Study

In a report titled "Cost of Developing Highway Projects", the California Department of Transportation (Caltrans) analyzed the data and procedures used to report project development costs by California and other states. This study was in response to severe criticism leveled at Caltrans based upon a published report stating that California's average annual cost of engineering exceeds 44% of total capital outlay. The national average (for all states combined) is 15%.

In September, 1991, the "Professional Services Management (PSM) Journal" published a report titled "The Effect of Contracting Out On Engineering Costs." This report was prepared for the American Consulting Engineers Council and was developed from data submitted annually by the states to the FHWA. Caltrans prepared its own analysis of the cost of developing highway projects. The Caltrans report compared the methods used by five other large states (Florida, Illinois, New York, Pennsylvania and Texas). The Caltrans report concluded that the California costs averaged 16.5% over the last three years when using consistent data and methodology. It concluded that the 1991 PSM Journal article's study methods and data used to compare states were flawed and led to inaccurate conclusions. An exchange of correspondence between Caltrans, FHWA and the PSM Journal, along with the Caltrans report, raises important

relevant issues concerning why inconsistencies in data reporting and inconsistent methodologies can lead to flawed conclusions.

The Caltrans analysis was based upon a very detailed study carried out by the University of California at Berkeley. That study collected detailed cost data for highway projects designed by in-house Caltrans personnel and for projects designed by outside contractors. The average costs of the projects showed that there were no significant differences between the cost to design a project in-house compared to the cost of contracting for those services. The study revealed that there are inconsistencies in data reporting by the states to FHWA and in methodologies used to evaluate comparable performance measures.

2. Approach Used: Kansas Study

The Kansas DOT contracted with the firm Peat, Marwick, Main & Co. to assess the present operations and to make recommendations to strengthen the management policies and practices, the organizational structure and staffing of KNDOT.

This report is similar to those prepared by the HUF. The analysis included a review of practices in three "peer" states (Iowa, Nebraska, Oklahoma), and interviews with state personnel. The conclusions indicated that the KNDOT was comparable to the programs in those states, relative to "performance" criteria that are published by the FHWA. The focus of the report was on management and organization.

3. Approach Used: Nebraska

A "Report to the State Board of Equalization," prepared by the Nebraska Department of Roads in 1986, answers the question posed by the Governor, "Why is the Nebraska gas tax so high?" It compares fiscal, demographic, mileage and condition statistics to six surrounding states. This study shows that the "raw statistics" (such as the amount of the state gas tax) do not tell the whole story. For example, Nebraska has the highest gas tax, but the lowest price at the pump for gasoline purchases. Nebraska's pavement condition is better than that of the surrounding states. The gas tax is also used to support other state functions (i.e., other than highways). This study illustrates that raw statistics may often compare "apples with oranges."

4. Approach Used: New Jersey

In a report titled "Nationwide Variations in the Cost of Highway Construction: Implication for Future Surface Transportation Policy," the New Jersey Transportation Coordinating Council, Committee on Transportation Financing, showed that there are significant cost variations in highway and bridge costs across the nation. It was developed as a resource to make a case for Congress to include these factors in allocating ISTEA funds. Using FHWA data (submitted yearly by each state), the study showed that the costs of highway and bridge construction vary by well over 100% among states. This is a very significant fact when comparing state needs and the ability to meet those needs. The report also emphasizes significant (but explained) inconsistencies in the FHWA statistics that are reported by each state.

5. Approach Used: Texas (1)

The Texas DOT has undertaken a series of studies to establish more precise measurements of highway system performances using the Analytic Hierarchy Process (AHP). The report comments on the Highway Performance Monitoring System (HPMS), which is the analytical computer model used by the FHWA as the basis for assessing highway needs and costs nationwide. Used since the late 1970's, each state collects sample data for a composite index of nine variables that quantify highway condition performance. The HPMS model is highly sensitive to the component weights of the performance functions, so some states have begun modifying "national average" default values in the model in order to represent their own specific highway condition priorities. The report stated that: "Failure to correctly quantify these priorities would cause the model to optimize the wrong factors, producing an inappropriate highway strategy for that state."

The purpose of the research described in this report was to examine what the weights should be in the HPMS model and how "Analytic Hierarchy Process" can improve the confidence in these determinations. The research concluded that all significant measurements of highway performance are not equally important, and that relevant weighting factors are needed. The report demonstrated how subjective weightings can be made with increased confidence using a feature of the Analytic Hierarchy Process. This is a very relevant analysis of the HPMS process that appears to clearly demonstrate that all measures of performance are not equally important. The key conclusion is that more meaningful weighting factors are needed.

6. Approach Used: Texas (2)

Another Texas DOT research report is titled "Assessing DOT Operational Efficiency with Data Envelope Analysis." Its purpose is to discuss the potential value of Data Envelope Analysis (DEA) in assessing the efficiency of the operational units of the Texas DOT.

DEA is a rigorous mathematical method developed over the last decade by Charnes and Cooper to analyze and compare operating efficiencies. Texas DOT examined the potential application of DEA to make comparisons between SHD District Offices for all functions (maintenance, construction, etc.). If successful, it could be used to evaluate the performance of all activities for each District.

This Texas study concluded that comparison of "efficiencies" to average values do not give useful information about how to attain peak efficiencies. This is especially true when there are multiple outputs and multiple complicating factors to take into account. The study shows how the DEA approach can provide supportable overall performance measures when multiple complicating circumstances must be correlated, while avoiding subjective weightings with some type of optimization technique.

7. Approach Used: Utah

In a report titled: "Revenue Available to Transportation Programs," the Utah DOT analyzes taxing sources that are used primarily for highway purposes in Utah. Utah DOT conducted this study in 1991 to show

transportation funding sources available in other states. It resulted in a table of "cents per gallon equivalent tax revenue" for each state. This resulted in a range of 78.6 cents for New York to 22.6 cents for South Carolina.

There is such a broad diversity in tax sources that this provides good reasons for the need to consider the many diverse conditions among different states. It is interesting to note that small rural states such as Kansas, New Hampshire and Nebraska have "equivalent" values that are in the same relative range as for very large urban states such as Minnesota, Wisconsin, Maryland, New Jersey, etc.

2.3.2.4 State Comparative Analyses

There were only two reports found that evaluated the performance of State DOT's on a national basis; they are summarized below.

1. "Measuring State Transportation Program Performance," November 1992, Final Report prepared for NCHRP by HUF.

The following is taken from the abstract of this final report.

"This report identifies key program performance measures and indicators needed by chief administrative officers of state highway and transportation departments for effective and efficient administration of state highway and transportation programs. The report also contains information on states' usage of these measures and indicators; the need to tailor the measures to each program; and the need to set goals and objectives against which transportation program performance can be evaluated. Finally, in recognition of the rapid turnover of state chief administrative officers in recent years, the report contains a compendium of basic information for the early needs of newcomers to state transportation program management. The suggested program performance measures are offered as the basis for Executive Information Systems (EIS). Much of the information is based on responses to a 1991 survey of the states and Canadian provinces. However, much is also attributable to the research team's recent experiences (14 states over the 1984 to 1992 period) in advising state highway and transportation officials on program management issues. Overall, the report responds to the current issue of citizens' demands for improved accountability for public resources."

Following is a summary of the conclusions reached by the study.

- (1) Program performance measures will become increasingly important tools for legislators and citizens in judging the performance of public programs and in holding officials accountable for the efficiency and effectiveness of their programs.
- (2) The nation's highway and transportation officials will lead the way for other state officials in the use of performance measures, as they have in adapting to computer technology and many other productivity enhancements.
- (3) Much of the information needed to establish systems of transportation program performance measures -- more

commonly referred to as Executive Information Systems (EIS) -- are readily available. However, in order to make full use of program performance measuring systems, state highway and transportation departments need to devote more resources to monitoring the physical condition and the services provided by state supported transportation systems.

- (4) Program goals are needed as benchmarks for measuring program performance.
- (5) All state highway or transportation programs differ in mission, scope and goals. Therefore transportation program performance measuring systems have to be tailored to each state's needs.
- (6) Chief administrative officers can use state-to-state comparisons of program performance in decisions on budgets and staffing. However, when comparing the performance of one state highway program with another, it is important to select states of similar geography, topography, population, etc., and then to use the information judiciously.
- (7) Beyond the use of performance measures to judge overall program performance, there are other opportunities to use performance measures to improve the management of the many processes needed to accomplish state transportation program missions."

2. "Resources Versus Results: Comparative Performance of State Highway Systems: 1984-1990," July 1992, prepared by UNC/Charlotte.

This study examines the overall performance of the U.S. highway system and of each state over the period 1984-1990. The intent was to compare changes in system performance over time, in relationship to resources expended and in relationship to other states' and national averages for the same performance measures. A letter grade was then assigned to each state by relating the state's performance over time to the national average, and by determining if the state's performance was improving, staying constant, or declining relative to this benchmark. The specific data items selected for tracking were: 1) total miles of highway under state control, 2) total receipts for state controlled highway systems, 3) capital disbursements for highways, 4) maintenance disbursements, 5) administrative disbursements, and 6) total disbursements. The state performance measures included: 1) percent of rural and urban interstates with a PSR less than 2.5, 2) rural other principal arterials and urban other freeway and expressways with pavement condition less than a PSR rating of 2.0, 3) percent urban interstates with V/C ratio greater than 0.7, 4) percent deficient bridges, and 5) fatal accidents per 100 million vehicle-miles. The data for the study came from reports submitted by the states to the Federal Highway Administration, in particular data submitted as part of the Highway Performance Monitoring System, the National Bridge Inventory System, and the Fatal Accident Reporting System. In order to take into account different sizes of state highway systems, the data were normalized to national averages, all revenue and disbursement statistics were divided by centerline mileage on the state-owned system, and each year's data were treated separately.

The paper concludes that the U.S. highway system is improving in performance and has been doing so since the early 1980's. With regard to the ranking of the 50 states, there was no discernible relationship established between the ranking for each state and geographic location, although it was noted that heavily urban states and those having a large percentage of through travel tended to be at the bottom half of the ranking. Those states with the highest unit costs appeared to be moving away from national averages rather than toward them. The authors conclude that the type of methodology outlined in this paper can be used by state DOT officials to better manage their state highway program.

The authors point out some of the limitations of the study. These include: 1) no use of lagged variables, 2) no treatment of travel from neighboring states, 3) labor cost differences across the country, 4) possible errors in the data base, 5) selection of the variables for analysis, and 6) no analysis of transportation need (e.g., changes in population or automobile registrations). However, the authors also state that these limitations of the study are neither fatal nor preemptive.

2.3.3 Application of Study Results To Individual States

With the exception of the two "State Comparative Analyses" reports summarized above, the studies undertaken by individual states have been used by those states to assist in the identification of methods, procedures and programs to improve their existing state highway programs.

In some cases, such as those summarized in Section 2.3.2.3, a number of special purpose studies have been undertaken to prove or reject assumptions that have been made about various aspects of state highway programs. In that section some very relevant points were made concerning the inconsistencies in the data reported to FHWA by individual states. Also, such as in the case of the California study, the methods used to analyze the same data resulted in conclusions that were significantly different.

The individual state analyses were also significant in that they were not aimed at a comparative analysis. Their intention was to evaluate specific activities or programs within that state. Although some "peer state reviews" were undertaken, it was made clear that state-by-state comparisons were not possible. This is because the unique characteristics of individual states make it difficult, if not impossible, to do so. Where some comparisons can be made, it is also clearly stated that such comparisons can be made only for those states having similar congestion, social, environmental, financial and demographic characteristics.

2.3.4 Potential for State Comparisons

Only two transportation reports were obtained that attempt to evaluate a large number of state highway programs, as described in Section 2.3.2.4. The HUF/NCHRP Report concludes that "...program performance measures will become increasingly important tools..." But, the report also concludes that all state highway or transportation goals differ in mission, scope and goals; thus, transportation performance measures must be tailored to meet each state's needs. It goes on to say that "... when comparing the performance of one state highway program with another, it is important to select states of similar geography, topography, population, density, climate, and state highway system characteristics, and then to use the information judiciously."

The second report prepared by the researchers at UNC/Charlotte uses FHWA statistics to rank the 50 State DOT programs from 1 (the best) to 50 (the worst).

This study is one of the first such studies that has attempted to apply a systematic, quantitative approach to comparing state highway program performance. As noted earlier, the means of doing so was by comparing the trends over time of an individual state's data on expenditures and resulting performance with national averages. Importantly, this work is one of the first in transportation that attempts to relate resource inputs with associated performance outputs. However, there are several limitations related to the analysis that should warrant significant caution in drawing conclusions about comparative performance of state highway programs — and the authors themselves identify and understand these limitations. The same national data can be interpreted differently by many different groups. For example, one critique of this paper pointed out that the 11 lowest ranking states as defined by the authors had the highest expenditure per mile of states in the country (a conclusion drawn by the authors). At the same time, these 11 states were included in a) 10 of 12 states with the highest average number of lanes per mile of state road system, b) 10 of 11 highest overall traffic per lane states, c) 11 of the 13 highest population density states, d) 11 of the 15 highest urban populated states, e) 10 of the 11 states with the highest percent of urban travel, f) 10 of the 12 most congested urban freeway states, and g) 11 of the 18 highest urban traffic per lane states. The point being made was that the need or demand for the road system clearly influenced both resource expenditure and system performance, and thus the methodology used in the study could not provide reasonable results for national comparative purposes.

Criticisms of this study have focused on several issues. Normalizing data for comparative purposes is an important approach, but some felt that using lane-miles, VMT or truck VMT as a normalizing factor would better take into account those characteristics of road systems that heavily influence performance and expenditures. Because of the often long time periods involved between changes in policy and the results, the use of time lagged variables would be appropriate. Importantly, some argued that construction costs vary dramatically from one region of the country to another, and thus national comparisons using dollars as a resource variable is misleading as clearly illustrated in the New Jersey report. Another major concern, as summarized in the California study, was the inconsistency in the quality or consistency of data provided by the states to the federal government, data which ultimately were used in this study.

It can be argued that any measure of the efficiency of DOTs should also include the time taken to complete transportation projects (and not just the cost of the project). For example, a certain project in one state may have cost 10 million dollars and started to provide service to the populace within 1 year of inception. A similar project in another state may cost 11 million dollars, but may start to provide service in only 6 months. Can it be decisively argued that the first project is more efficient simply because the second project cost 10% more? How about the 50% savings in time which the second project accomplished? Such factors are completely missing from the UNC/Charlotte report, and their impacts have not been acknowledged.

In an October 1992 update of the paper, the authors responded to the criticisms of the earlier paper by arguing that, even with some limitations, the approach was still valid, and, in the absence of better data or approaches, provided useful information. In particular, the authors agreed that incorporating "need" into the methodology would be valuable, but that there is no agreement on how to do so. In other situations, such as spillover traffic from other states or through traffic, the authors argued that there was no agreed upon measure or data to back up any measure that was defined. Overall, the authors felt that the study was a point of departure for the development of a good management tool that could be used to assess highway program effectiveness.

The use of this methodology for comparative analysis shows some promise. As it stands, however, there are several limitations that need to be addressed. As pointed out above, these limitations relate specifically to the inability of the methodology to take into account need, differential construction and labor costs, and other factors that could cause a state's resource input and performance output measures to be significantly skewed when comparing the national averages or to other states. The latter is particularly important because there are so many significant differences among the states in many of the performance "statistics."

2.4 Synthesis of Education Report

For the past several years, *U.S. News and World Report* has been providing a rank ordering of colleges and universities in the U.S. This is the only education report studied for this project.

2.4.1. Approach Used:

Here's how *U.S. News* ranked graduate schools of engineering for 1992:

- Student Selectivity:** This is based on two statistics for doctoral and master's degree candidates who enrolled in the fall of 1991, the percentage of applicants a school admitted and the "yield," or the percentage of those accepted who decided to attend.
- Faculty Resources:** This statistic is based on a number of variables — the current percentage of full-time faculty members holding Ph.D.'s, the current ratio of both full-time doctoral and master's degree candidates to full-time faculty, the current percentage of full-time faculty members, and the number of Ph.D. degrees granted in 1991.
- Research Activity:** Research activity has been measured by two indicators — the total dollar amount of publicly and privately funded research administered by the engineering school, and the total dollar amount divided by the number of faculty members doing research.
- Reputation:** The reputation of a program was determined by two surveys. The first survey, sent to all deans of engineering and/or academic affairs asked all respondents to rate each school by quartiles representing levels of academic quality. The second survey asked 785 practicing engineers to select the top 15 graduate engineering schools based upon their academic quality.

Overall rank was based upon the above criteria. Data for each of the above indicators were converted into percentiles. A value of 100 was assigned to the school with the highest score within each indicator, and the scores of other schools were determined as a percentage of the total achieved by the top school. Weight values were assigned to each factor (25% each to the two surveys, 20% each to faculty resources and research activity, and 10% to student selectivity), and a final rank computed.

2.4.2. Comments

The procedure adopted above, while compact and easy to analyze, is not without some flaws. The number of students applying to a particular school can depend on a number of hidden variables, one of the more notable ones being geographical location. Using this number to determine student selectivity could be particularly misleading. The idea of using dollar amounts to quantify research activity may be a pragmatic and utilitarian approach, but it says little about the quality of said activities. Finally, the lack of standard definitions for the data is perhaps the biggest flaw. Institutions submitted data to the magazine based on their own definitions or interpretations of the categories requested. A simple example can further illustrate this point.

One institution, for example, might count only those faculty with 100 percent appointments as full-time, while another might include all faculty with 51% (or more) appointment as full-time. Similar variation might exist in reporting full-time and part-time students. Further confounding the issue is the inclusion of professional librarians in the number of full-time faculty members (some institutions such as Texas A&M University give a faculty rank to all professional librarians).

Another common error occurs due to the usage of total student enrollment rather than full-time-equivalent numbers. The magazine calculated a 26-to-1 student-faculty ratio for The University of Texas at Austin, by dividing the number of full-time students (42,040) by the number of full-time faculty (1,637). The method used more frequently by institutions of higher education in calculating this ratio is based on Full Time equivalencies (FTE) of both faculty and students. Using FTE figures, the student-faculty ratio for UT Austin drops down to 21.9-to-1.

2.5 Comparative Program Evaluation Literature

The most traditional approach to comparative program evaluation is simply to identify key measures of performance and to then list the corresponding data for targeted systems in an evaluation framework, most usually a matrix. Such an approach resembles the evaluation matrix that is often found in transportation studies that shows the relative values of key characteristics of the alternatives under consideration. Classic examples of such approaches can be found in Ashford's Comparing Public Policies, Hyde and Shafritz's Program Evaluation in the Public Sector, and Parks' article "Complementary Measures of Police Performance" in Public Policy Evaluation. Few efforts have been made to attach a composite value to the relative worth of one program versus another.

The only book published which examines performance monitoring for state highway programs was written by Poister and entitled, Performance Monitoring (1983). In discussing a performance monitoring program established for the Pennsylvania Department of Transportation, Poister identifies a major issue that must be taken into account when interpreting the results of the system. He notes that numerous external factors can influence the ultimate performance of the system. Evaluating the ultimate performance of the highway system within this context needs "indicators and analytical approaches which can assess the effects of specific program factors, while controlling for the major influencing variables."

Transit planning and evaluation provides one of the few instances where efforts have been made to reduce the dimensionality of the "performance" of the alternatives under consideration so that the relative value can be assessed. This is found in the cost effectiveness index that is a required calculation for all applicants seeking federal monies for transit capital investment (see Urban Mass Transportation Administration, Process and Methods for Transit Service Planning (1986)). In essence, this index represents a dollar amount society will pay per new rider attracted to a new service. A threshold value is

established at the federal level above which federal funds (minus political intervention) will not be expended. This cost effectiveness index is an attempt to assign relative worth to alternatives under consideration. As noted earlier, the key way of doing this is to reduce the number of performance characteristics to a level at which relative worth can be determined. This is a key issue when trying to develop an overall approach for comparing the performance of alternative programs or facilities.

2.6 Studies on Organization Performance

Organization theorists have been conducting research on organizational effectiveness and performance for many years. The relevance of this research for this study is that it has examined several issues that are directly related to defining performance and linking it to resources expended. Organizational researchers have written numerous articles on the challenges of defining valid measures of performance, and on establishing the cause-effect relationship that is necessary to determine the effectiveness of resource allocation. Not surprisingly, much of the early research in the area focused on industrial organizations which related output (in quantifiable terms) to inputs such as labor and finance. Some of the more recent studies have examined the effect of the organization's environment on the structure and overall performance of the organization (see Lawrence and Lorsch, Organization and Environment, for some of the earlier work in this area). One of the major conclusions that has surfaced from much of this research is that it is very difficult to relate performance to input variables without accounting in some way for environmental factors. This is particularly true when attempting to conduct comparative assessments. As noted by Hannon and Freeman in their article, "Obstacles to Comparative Studies," there are four major methodological problems that are encountered when attempting to conduct a comparative study of organizational performance: 1) time horizon, 2) identification of system boundaries, 3) appropriate levels of analysis, and 4) identification of exogenous variables that could influence the ultimate performance measures but which are not accounted for in the input variables. These problems are certainly present in comparative assessments of program performance that also attempt to relate inputs to output variables.

One of the few studies in the transportation field that has attempted to examine the relationship between organizational performance and input variables was a study done for the Urban Mass Transportation Administration in 1978 (see Fielding et al, "The Effect of Organization Size and Structure on Transit Performance and Employee Satisfaction," 1978). This study collected data on 16 fixed route bus systems in California relating to organizational characteristics and system performance. Performance was measured in terms of service efficiency (e.g., revenue vehicle hours per vehicle) and effectiveness (e.g., total passengers per vehicle). The researchers concluded that, although one could generally associate certain relationships between input and output variables, there was no conclusive evidence to suggest that a direct cause-effect relationship existed. The concluding paragraph provided words of caution when trying to compare performance characteristics of different organizations, especially when first relating them to resources expended to produce this level of performance.

Perhaps the most important contribution of this literature to the study of highway program effectiveness is that comparative studies must be done very carefully, with a well-thought-out experimental design. Most all of the literature in this field suggests that evaluators must develop a strategy as part of the approach that controls for, or at least takes into account, external environmental factors that could influence the measurement of performance or resource input variables.

2.7 Summary and Conclusions

A review of the literature on the topic of program performance and comparative analyses suggested several noteworthy observations. Concerning highway program performance studies; the states and the FHWA collect large volumes of statistics annually. FHWA must rely upon the accuracy of the data submitted, and they do take steps to maintain as high a degree of quality control as possible. However, based upon the review of the studies available for this project, there are a number of precautions that must be observed when using these data. They include:

- inconsistencies in the methods of reporting;
- differences in the assumptions that are used in gathering and reporting;
- the absence of qualifying factors, such as urban congestion, costs of labor and materials, sources of funding, use of funding, environmental concerns, demographic conditions, geography, topography, etc.; and
- inconsistencies in the analysis methodologies

There is clear agreement that the inconsistencies in the available data make it very difficult to compare states based upon those data. However, there is also agreement that it is desirable that appropriate measures of performance be established that would allow for a comparative "peer" analysis of state highway programs. In the next chapter we develop more details concerning approaches to comparative performance measures.

CHAPTER 3

APPROACHES TO COMPARATIVE PERFORMANCE

3.1 Introduction

In Chapter 2 we summarized several studies of state DOT's that have been used to assess the performance of transportation programs that impact the lives of citizens in the United States. The purpose of this chapter is to focus upon what we have identified as several approaches used to evaluate the performance of state highway programs. We shall describe in more detail the following comparative analyses:

1. The HUF studies of State DOT's that have occurred over the past several years.
2. The NCHRP sponsored project completed by the HUF on "Performance Measures Used By State Highways and Transportation Agencies."
3. The California study on the costs of highway project design.
4. The New Jersey study on the variations in the cost of highway construction.
5. The Texas research that evaluated new methods for measuring highway program performance using the Analytic Hierarchy Process (AHP) and Data Envelope Analysis (DEA).
6. The FHWA Highway Performance Monitoring System (HPMS).
7. The UNC/Charlotte study titled "Resources Verses Results: Comparative Performance of State Highway Systems."

For each of the above approaches we will present the following analysis:

- Motivation for undertaking the study,
- Sources of data,
- Discussion of the methodology/approach that was used,
- Criteria/factors used to assess program performance, and
- Potential for making state-by-state comparisons or rank-orderings.

3.2 The HUF Studies of State DOTs

3.2.1 Motivation For Undertaking the Studies

As reported earlier, during the past ten years the HUF has undertaken more than a dozen comprehensive studies of state DOT programs and operations. Each study has been undertaken because of a specific request from a state agency to do so. Those requests are based upon a desire on the part of the state to critically and objectively evaluate overall program performance.

One of the most recent of those studies was undertaken for New Hampshire. The final report is titled: "An Evaluation of the Management of the New Hampshire State Program." It was presented to the New Hampshire Highway Program Review Advisory Committee, which included representatives from the State Legislature and the New Hampshire DOT.

Since the New Hampshire report is typical of those prepared by the HUF, it is used in this study as representative of those completed by the HUF.

3.2.2 Sources of Data

The HUF has been involved with this type of analysis for many years. As in the case of New Hampshire, a study team spends considerable time in residence at the State DOT. The team collects and analyzes reports, studies and data that have been developed by the DOT. The HUF study team also interviews many individuals in the state (within and outside the DOT). A comparative analysis is also made using data from HUF files and from the FHWA. Every attempt is made to make possible a comparative analysis of "like" states.

3.2.3 Discussion of Methodology

The review of the data and interview material is undertaken by experienced HUF engineers. Their observations and analyses are made as constructively and objectively as possible, based upon a detailed and exhaustive evaluation of facts and ongoing programs.

3.2.4 Criteria/Factors Used to Assess Program Performance

The New Hampshire study is typical of the HUF studies. In this case, the following were evaluated.

1. Highway Finance, including
 - Travel on state highways
 - Total expenditures
 - Correlation of travel and funding
 - Personnel costs
 - Construction costs
 - Maintenance costs
 - Sources of funds and needs
 - Local road finance
 - Fund projections
2. Highway Condition and Performance, including
 - Pavement condition
 - Bridge condition
 - Local condition
 - Safety
3. Highway Program Needs, including
 - Organization and management
 - Plans and programs
 - Legislative involvement
 - Federal programs
 - Public participation
 - Maintenance and operations

4. Management and Productivity, including
 - Current organization
 - Proposed reorganization
 - Strategic planning
 - Analysis of other state programs funded with highway user taxes and fees
 - Administration
 - Personnel and training
 - Private sector involvement
 - Equipment and facilities
 - Management systems

3.2.5 Potential for Comparison of New Hampshire to Other States

An appendix compares critical data obtained for New Hampshire to the same data obtained for five other states (Vermont, Maine, Massachusetts, Idaho and Nebraska). No attempt is made to evaluate one against the other. Even though some of the characteristics of the six states might be considered similar, there are so many significant differences that it does not appear possible to compare them or to rank order the states for any given objective function.

3.3 The NCHRP Sponsored Project Completed by HUF

3.3.1 Motivation for Undertaking this Study

The NCHRP sponsored this project titled "Measuring State Transportation Program Performance." The final report is dated November 1992. The study was generated by AASHTO and undertaken through the NCHRP program process. Its purpose was to isolate and describe the key program performance measures and indicators needed by all administrative officers of state highway or transportation departments in administering state transportation programs.

3.3.2 Sources of Data

A survey questionnaire was sent to 50 state DOT's, the District of Columbia, Puerto Rico and ten Canadian Provinces to gain a national consensus of:

1. A set of program performance measures for evaluating the effectiveness and efficiency of state transportation programs; and
2. A set of internal management factors that should be used in managing state programs.

3.3.3 Discussion of Methodology

Forty-two states, the District of Columbia and eight Canadian Provinces returned completed questionnaires. The data summaries are included in the final report.

This was one of the most extensive surveys of this nature ever performed. It provided the substance needed to meet project objectives.

3.3.4 Criteria/Factors Used to Assess Program Performance

The survey described above used fifty-four questions to obtain data on the performance of the entire transportation system. They included information for:

- The highway system
- Highway program costs
- Highway needs and condition
- Highway improvements
- Highway safety and risk management
- Mass transit service use and cost
- Air transportation
- External factors

In addition to the above, a comprehensive set of data were collected concerning performance measures. They included:

- Financial (5 data items)
- Improvement programs (7 data items)
- Human resources (9 data items)
- Other factors (2 data items)

The comprehensive data were then subjected to an exhaustive analysis, under the direction of NCHRP Panel and Staff, composed of eleven experienced professionals. The conclusions and recommendations were based upon their analysis of the survey results.

3.3.5 Potential for Making State Comparisons

The NCHRP project panel and the HUF Staff responsible for the study concluded that it is not possible at this time to realistically compare the performance of State DOT's, because there is a clear absence of consistent and accurate information for doing so. However, the study does recommend that there is a need to develop such data and provides the mechanics for doing so.

3.4 The California Study of Design Costs

3.4.1 Motivation for Undertaking This Study

As summarized in Chapter 2, this study was undertaken because a report published in the "Professional Services Management Journal" (PSMJ) in 1991 concluded that the cost to design highway projects by in-house Caltrans personnel was approximately three times the national average. This caused significant controversy in California. Consequently, Caltrans undertook their own analysis.

3.4.2 Sources of Data

PSMJ based its report on data compiled by the FHWA. The source of those data is the individual state DOT's. The Caltrans analysis used the same data. Their study concluded that inconsistent data furnished by the states to FHWA results in a very inconsistent tabulation of results.

3.4.3 Discussion of Methodology Used By Caltrans

The FHWA acknowledges that differences exist in the manner in which states report the requested statistical data. Although the data are valid for many statistical evaluations, they were not collected, nor intended to be used, to compare engineering costs between states (some items may or may not be included by all states in their cost calculations). Consequently, it was concluded that the FHWA statistics used as the basis for the PSMJ study cannot be used to accurately compare California's engineering costs.

In an attempt to determine the magnitude of differences in reporting costs, Caltrans surveyed 14 other state departments of transportation regarding specific types of expenditures included or excluded in their annual statistical report to the FHWA.

The survey showed that California reports more items as engineering costs than any other state contacted. As an example, some states classify a portion of their engineering costs as administrative expenses, while others classify construction engineering as a highway construction item. California does neither.

Some of the other major areas of difference among reporting systems used by California and other states include:

- Employee benefits
- Construction engineering cost classification
- Engineering for specially funded projects
- Internal classification centers
- Engineering for future programming

3.4.4 Criteria/Factors Used to Assess Program Performance

The factors used to assess the engineering costs of Caltrans' projects appeared to be more comprehensive than those of the analysis reported in the PSMJ, even though the assumption was made that the data were consistent. Consequently, the Caltrans study concluded:

- California's project development cost for highway projects has averaged 16.5 percent of total capital outlay over the last three years.
- Published reports stating that California's average annual cost of engineering exceeds 44 percent of total capital outlay are wrong.
- The study methods and data used to report an unacceptably high cost of engineering were flawed and led to inaccurate conclusions.

3.4.5 Potential for Making State-by-State Comparisons

This study showed clearly that an in-depth analysis is required in order to correctly utilize data from statistics reported by states to FHWA. There are too many inconsistencies in the reporting mechanisms to allow for "micro-level" (i.e., state-by-state) analysis, even though the data may be useful for national "macro-level" analysis.

3.5 The New Jersey Study

3.5.1 Motivation for Undertaking This Study

As reported earlier, the New Jersey Transportation Coordinating Council undertook a study of highway construction costs to determine if there are significant differences among the states. That being the case, New Jersey then argued that federal aid highway financing distribution formulas were not equitable.

3.5.2 Sources of Data

The extent and distribution of cost variations around the country were investigated using data from FHWA (which are obtained from each state) and private sector sources.

3.5.3 Discussion of Methodology

Based upon the analysis of available data, overall it was found that the difference in spending power of federal highway aid can be well over 100 percent between the highest and lowest cost states. The specific findings of the analysis included the following:

- Based on FHWA data used to allocate bridge program funds among states, the cost-per-square-foot of replacing a bridge varies by as much as 337 percent between the highest and lowest cost states.
- Analysis of FHWA data on the price of six contract items commonly used in highway construction found a lower but still wide (137 percent) difference in the spending power of federal aid between the highest and lowest cost states.
- New Jersey ranked among the highest cost states based on both the FHWA's bridge and highway data. Its bridge replacement cost of \$100 per square foot is almost twice the national average of \$58.
- Aggregated by census region, the highway construction data suggest that four regions on the two U.S. coasts -- Middle Atlantic, New England, Pacific and South Atlantic regions -- experience the greatest disadvantages in the spending power of federal aid. Together, these regions, representing twenty-two states and the District of Columbia, account for 53 percent of the U.S. population.
- States ranking among the top twenty in high costs based on both the FHWA bridge and highway data were the following:

Hawaii	Pennsylvania
Connecticut	West Virginia
Massachusetts	Delaware
New Jersey	Maryland
Maine	California
New York	Ohio
Rhode Island	Washington
Vermont	New Mexico

- Analysis of data on prevailing wages in selected metropolitan areas and on prices of nine highway construction materials in selected cities tended to confirm the existence of wide differences in the cost of highway construction.
- The prevailing base wages for power equipment operators and laborers on highway projects were found to differ by 182 percent and 191 percent, respectively, between the highest cost and the lowest cost metropolitan areas.
- The prices for highway construction materials were seen to be influenced not only by overall regional cost structures but by specific local market conditions affecting each material, such as the number of local suppliers of a material.
- Additional burdens on high cost states were found resulting from the expenses faced in acquiring Right-of-Way and relocating homes and businesses to make way for improvement projects.

3.5.4 Criteria/Factors Used to Assess Program Performance

The report analyzed detailed construction cost data. It was possible to evaluate the differences between states, because the data are considered sufficiently accurate for the purposes of the study.

3.5.5. Potential for Making State-By-State Comparisons

This study clearly illustrates that it is not possible to reasonably compare construction and maintenance programs between states using cost data as reported by FHWA, unless an appropriate accounting is made of the significant differences that exist in construction costs. This is not necessarily so because the reported data are incorrect, but more so because there is a significant variation in the items categorized under construction and maintenance costs.

3.6 The Texas DOT Research Studies

3.6.1 Motivation for Undertaking This Study

The Texas DOT has been actively involved in performance measurement issues recently, because the Texas state government is currently revamping the statewide budgeting process. The Division of Planning and Policy Staff at the Texas DOT has identified the problem of synthesizing multiple measures in the most critical area of performance measurements. Consequently, they have focused on the problems through a series of organizational pilot studies using promising techniques from the field of management science/operations research.

3.6.2 Sources of Data

The data used for the work reported by Texas DOT is based primarily upon their own internal studies. Also used are the FHWA methods, procedures and data, such as the HPMS monitoring programs.

3.6.3 Discussion of Methodology

The following five reports have been developed by the Texas DOT as part of their research. For each they have indicated its relevance to this study.

1. High-Precision Determination of State HPMS Component Weighting Factors Using the Analytic Hierarchy Process; Relevance: Since all significant measures of performance are not equally important, weighting factors are needed. Subjective weightings can be made with increased precision using a feature of the analytic hierarchy process.
2. Improving R & D Project Selection With the Analytic Hierarchy Process; Relevance: The overall performance rating for a state system should encompass the significant individual performance scores together with their weightings. The full analytic hierarchy process could provide the framework to meld the scores and weightings to produce a complete overall measure for a full system. This presentation demonstrates how this method produces merit scores for alternative research projects.
3. SDHPT Performance Measurement Project – Assessing Effectiveness and Efficiency; Relevance: Extensive lists of performance effectiveness measures are relatively easy to compile, but the numerous resulting efficiency measures are difficult to interpret as a group. This briefing paper presents a basic framework for such evaluations and the associated problems.
4. Assessing DOT Operational Efficiency with Data Envelopment Analysis; Relevance: Comparisons of efficiencies to the average do not give useful information about how to attain peak efficiencies — especially when there are multiple inputs and outputs, and a host of other complicating factors, to take into account. This presentation discusses how the DEA approach can produce supportable overall performance measures under these circumstances, while avoiding subjective weightings with an optimization technique.
5. A Pilot DEA Analysis of Maintenance Section Relative Efficiencies; Relevance: The comparisons among state systems desired by AASHTO can be viewed as analogous to comparisons among maintenance sections within a state. This report presents the results of using DEA to analyze Texas maintenance sections, producing both overall measures and attainable improvements at the input and output level of detail.

3.6.4 Criteria/Factors Used to Assess Program Performance

In Chapter 2 we summarized two Texas research reports which provide a unique insight into the application of various measures of performance, using the Analytic Hierarchy Process (AHP) and the Data Envelope Analysis (DEA).

The Highway Performance Monitoring System (HPMS) is an analytical computer model developed by the Federal Highway Administration, originally to assess highway needs and costs nationwide. It is now being adopted by states as a highway planning tool.

One of the ways of determining highway improvement needs with HPMS is to direct the system to maximize its "Composite Index," a performance measurement

function which is a weighted summation of nine quantified highway condition factors. The model can be run with no budget limit to determine total needs, or it can be run with a constrained budget to determine the priority set of highway improvements. However, the model is sensitive to the component weights in its performance function, and some states have modified the national average default values in the model to better represent their own specific road condition priorities. Failure to correctly represent these priorities would cause the model to optimize with the wrong factors, producing an inappropriate highway strategy for that state.

The Texas study finds that while the order of the rankings produced by the two approaches (i.e., HPMS and AHP) are similar, there are substantial differences between the two sets of numerical weighting values. Because the AHP method does not produce the numerical biases seen in a single-step method, it appears that AHP yields these preferences with greater precision.

3.6.5 Potential for Making State-by-State Comparisons

The application of AHP to evaluate the performance of transportation programs was applied successfully by the Texas DOT. It identified a number of significant problems in using the HPMS approach. This is not a criticism of the HPMS program, but it illustrates that great care must be used in applying the data available for that purpose.

3.7 The Highway Performance Monitoring System (HPMS) Program

3.7.1 Motivation

One of the most important data collection activities in the U.S. relating to the assessment of transportation system performance is the Federal Highway Administration's Highway Performance Monitoring System (HPMS). The FHWA developed the concept of an HPMS database and corresponding analytical process so that it could assess on a continuous basis the condition and performance of the nation's highway system. In particular, this approach has been useful in developing the periodic report to Congress on the performance of the highway system that is required by law.

3.7.2 Sources of Data

State departments of transportation collect traffic performance and facility condition data on a select sample of highway segments in their state. For each sample section, there are approximately 70 data items collected ranging from traffic counts to geometric design characteristics. The extent of data collection depends on the functional classification of a road. Freeways, for example, have a greater sample size than local roads. Data such as traffic counts is collected on a cyclical basis. The FHWA requires states to submit data for state highways and for highways under the jurisdiction of other government entities. Nationally, over 100,000 sample sections are part of the HPMS data set.

3.7.3 Discussion of Methodology

The HPMS database is used by the FHWA to prepare reports to Congress on the status of the nation's highway system. The methodology used for determining future performance is the HPMS Analytical Process (several states and metropolitan areas used this Process as well.) The base case is calculated by using the condition, safety, and performance.

Future conditions on the road system are estimated through formulas which reflect condition deterioration and demand increase. A composite index for future years is then calculated which provides a relative "effectiveness" measure of system performance.

The analysis determines the level of funding needed to keep the highway systems at a condition and performance level above pre-defined minimum tolerable condition. The process examines each sample section in the database to determine if the section characteristics are greater than these minimum tolerable conditions. The model then "makes" improvements to the sample sections where deficiencies exist based on an improvement priority. The priorities are capacity-related deficiencies such as low operating speed, high V/C ratio or insufficient lane width; pavement deficiencies, and alignment deficiencies (rural areas only).

The Process considers three major types of improvements — reconstruction, widening, and resurfacing. Once an improvement is made to a sample section, the section's data record is changed to reflect the upgrading received. The costs assigned to the improvement are nationwide average values for construction and right-of-way. The nationwide costs are then adjusted based on relative State cost index. The average values are calculated from the costs reported by the states, reduced to a per-lane basis. Different funding strategies can be used to estimate what effect they will have on the future effectiveness of the road system (i.e., how they affect the future composite index). These funding strategies relate to a set of priorities that can be established within the model for the types of reconstruction, rehabilitation and maintenance activities that could be emphasized. For example, one funding scenario might be to maintain pavement conditions at their current level. Another might be to provide as much capacity to handle demand as is feasible. For each scenario, the Analytical Process will indicate the level of funding that is necessary to meet the objective, and the resulting system performance.

3.7.4 Criteria/Factors Used to Assess Program Performance

System condition and performance is reduced, through a weighted function, to a dimensionless index (the composite index). Each component of this index has several factors that relate to its relative value. These factors are as follows:

Condition

- Pavement type
- Pavement condition
- Drainage adequacy

Safety

- Lane width
- Shoulder width
- Median width
- Alignment adequacy

Services

- Operating speed
- V/C ratios
- Access control

The relative comparison of this index over time provides a comparison of whether the system is improving or deteriorating.

3.7.5 Potential for Making State-by-State Comparisons

The HPMS Analytical Process has some merit in comparing state highway programs. By reducing the important factors to a dimensionless composite index, one state's performance could be compared to another. However, there are important factors that influence the validity of this approach. Most importantly, the validity of the output depends very much on the quality of the input data. For comparative purposes, the data procedures and approaches would need to have a high level of standardization. In addition, the weights assigned to the development of each composite index would either have to be the same, or accurately reflect the priorities of each state. The comparability of the weighting scheme from one state to another is the greatest challenge in using HPMS for comparative purposes.

3.8 Federal Transit Administration Section 15 Monitoring

3.8.1 Motivation

Section 15 of the Urban Mass Transportation Act (amended) required that transit operators submit to FTA data on costs and service. Similar to FHWA's HPMS database, this data is used by the Federal Transit Administration to submit to Congress every two years a report on the status of the nation's public transportation performance and condition.

3.8.2 Sources of Data

Every transit operator is required to submit a wide variety of data on their respective cost and service characteristics. This data is submitted annually. Examples of the type of data submitted include total operating revenues, dedicated state operating assistance, total capital revenues, dedicated local capital assistance, etc.

3.8.3 Discussion of Methodology

The methodology used for developing national statistics and comparisons between transit properties is straight-forward. The performance indicators are calculated as a weighted average of urbanized area totals which are aggregates of all reporting operators in the urbanized area. For national comparisons, areas of similar size are grouped. Of interest for this report is a statement made in one of the reports to Congress which relates to performance measures,

"Measures of external transit performance are not well established. Conceptually they would be analogous to the highway measures and might include such factors as coverage, service frequency, travel time, ride quality, crowding and comfort. Resulting benefits from changes in performance over time along these lines would include reduced travel time and cost for users and economic efficiency improvements for non-users. The body of knowledge which exists on these subjects is extremely limited.... thus this report provides only limited treatment of the external performance of transit...."

3.8.4 Criteria/Factors Used to Assess Program Performance

As noted above, transit operators are required to submit data on costs, revenues, and service levels. This base data is then aggregated for national comparative purposes

(e.g., by size of operator or region of the country). Some researchers have used this data to provide comparative evaluations of individual transit operators with such criteria as operating cost per rider.

3.8.5 Potential for Making State-by-State Comparisons

This approach does not lend itself well for state-by-state comparisons because it has great difficulty incorporating into the analysis the external or environmental considerations that can affect a state's program performance. The Section 15 program, and those few reports which have attempted to undertake comparative evaluation of transit properties, has been criticized by the transit industry in particular for failure to take these factors into account.

3.9 The UNC/Charlotte Comparative Analysis of State Highway Programs

3.9.1 Motivation

This study was undertaken to develop a methodology that could be used by transportation managers to better understand and assess the performance of their highway program. In particular, the authors state that few comparative assessments have been done that compare costs incurred versus performance obtained. Therefore, one of the major contributions of this paper was an attempt to develop a methodology that allowed one to compare both resource variables and performance variables at the same time. This study illustrated the application of such an approach by conducting a national assessment, resulting in a relative ranking of all 50 states.

3.9.2 Sources of Data

Every state DOT submits data annually to the Federal Highway Administration on a wide variety of highway program characteristics, including performance measurements, resources consumed, and finance/expenditures. In addition, state DOT's provide data for several national data reporting systems that are used by the FHWA to assess national trends and policy implications of alternative finance scenarios. The most used reporting systems include the Highway Performance Monitoring System (HPMS), the National Bridge Inventory System, and the Fatal Accident Reporting System. This report used the data that had been submitted to the FHWA by the states.

3.9.3 Discussion of Methodology

The resource and performance measures for each state are measured for that portion of the state road system under the jurisdiction of the state transportation agency. Resources expended are measured by total receipts and expenditures per centerline mile of responsibility. The resulting data are normalized against national averages over time. Performance is measured as the percent of pavement deterioration and congestion on the highest classified state systems, and by percent deficient bridges and fatal accident rates for the state. A letter grade was then assigned to each state by relating the state's performance over time to the national average, and by determining if the state's performance was improving, staying constant, or declining relative to this benchmark. A template for determining this letter grade is found in the paper.

The authors discuss the criticisms of the methodology in the report and respond as follows:

1. Selection of inappropriate variables, particularly the use of centerline mileage as normalizing factor: Centerline mileage is the only normalizer that is consistently available in the data base.
2. No measure of need: Change in population could be used to measure need, but there is no agreement on how to use this measure.
3. Traffic effects from bordering states: There are no available data on the percent of such traffic in each state.
4. Use time series or lagged statistics: Using lagged data would be helpful.
5. Differences in construction costs around the country: A more complete study would account for such variations; FHWA publishes selected regional cost data.
6. Use of relative ranking: Ranking is appropriate for highway systems, and the data bases used in this study are appropriate for comparisons.
7. Use of data for unintended purposes: The data were used appropriately.
8. Differences in state data collection: Differences in states' measurement of data items have declined over time as uniform procedures have been adopted.
9. Mixed responsibility within state for highway system: Data are not well documented for all road systems, especially non federal-aid-systems. The data in this study focus on highway expenditures and do not include non-highway expenditures.
10. Lack of urban focus: There is no reason to just include urban factors if such is desired to take into account unusual circumstances. One should also need to include factors to account for traffic, weather, climate, trucks, etc.
11. Inappropriate use of data: This analysis is of systems, not agencies. The data are used appropriately.
12. Differential inflation: Using different inflation rates for individual regions would be useful, but is beyond the scope of this study.

The authors conclude that the above limitations are neither fatal nor preemptive. They argue that work should continue on the development and analysis of transportation performance measures in spite of these problems.

3.9.4 Criteria/Factors Used to Assess Program Performances

Program performance was based on the temporal tracking of several state data items. They were: a) total miles of highway under state control, b) total receipts for state controlled highway systems, c) capital disbursements for highways, d) maintenance disbursements, e) administrative disbursements, and f) total disbursements. The state performance measures included a) percent of rural and urban interstates with a PSR less than 2.5, b) rural other principal arterials and urban other freeway and expressways with pavement condition less than a PSR rating of 2.0, c) percent urban interstates with V/C ration greater than 0.7, d) percent deficient bridges, and e) fatal accidents per 100 million vehicle-miles. As noted earlier, "performance" was then determined by comparing the trend in a state's data to national trends, and using a template to assign a letter grade.

3.9.5 Potential for Making State-by-State Comparisons

The authors portray this study as an important point of departure for developing a methodology that can be used to develop valid comparative assessments of state highway program performance. It is one of the first studies in highway performance that attempts to relate resource inputs to performance outputs. It does produce a ranking of states based on a benchmark of national trends. However, the effort at establishing causality between resource expenditures and performance, and then determining relative position of one state versus another requires a more careful consideration of those factors that could, in fact, explain resource or performance levels, rather than assuming they occur because of the simple relationship between the two.

3.10 Summary and Conclusions

The purpose of this chapter has been to summarize selected studies that have been used to assess various aspects of the performance of state transportation programs. Although each dealt with various aspects of program performance, each was also quite different in its motivation and in the approach used to achieve the stated objectives.

The studies illustrated the following relative to their potential for making state comparisons:

1. The data used for such purposes must be consistent in quality and appropriateness for the objectives to be served;
2. The analysis methodology must be appropriate and consistent if state-by-state comparisons are to be made;
3. External, often uncontrollable factors make it difficult and often inappropriate for the comparison of states; and
4. The inappropriate comparisons of state data can lead to inaccurate conclusions and be counterproductive in their misuse.

Throughout this report we have alluded to the desirability of establishing program performance measures. In the next chapter we suggest a possible approach to highway program assessment, with an appreciation for the major pitfalls to be avoided in doing so.

CHAPTER 4

CHARACTERISTICS OF GOOD HIGHWAY PROGRAM ASSESSMENT

4.1 Introduction

The previous chapters have examined the current state-of-practice of comparative program assessment. In most instances, the literature has recommended a great deal of caution in undertaking comparative studies. This caution has been particularly focused on the "control" of external factors that could influence program performance but which were not captured in the input variables. Therefore, it is important to develop overall guidelines for highway program assessment that considers the role of external factors and yet produces information useful to highway program managers. The characteristics of such assessment are discussed in this chapter.

4.2 Conceptual Framework for Program Assessment

The characteristics of a good assessment of programs can be derived directly from a basic understanding of the underlying phenomenon being examined and how key variables relate to one another. One way of accomplishing this is to develop a conceptual framework of the program development process which leads to an understanding of how highway system performance is actually achieved. This framework recognizes that the inputs into program delivery are primarily the domain of state transportation agencies, and thus are subject to all of the organizational priorities that influence how these inputs are used. Importantly, this framework also recognizes that there is a distinct difference between organizational outputs and the actual outcomes that occur over time. This is primarily oriented to the external factors (the giant question mark) that can influence these outcomes. From a methodological perspective, this means that fair and valid comparisons of one system's performance to another's requires some way of taking the external factors into account. Only by controlling for these external factors can one produce a consistent and valid comparison.

The conceptual framework suggests three major elements of an assessment methodology that need to be discussed — performance measures, input variables and external factors.

Performance Measures: The measures used in assessing the performance of a system must be defined appropriately and must be truly measuring the desired effect of program implementation. In the transit industry, for example, it took many years before appropriate performance measures were defined for transit service. These focused primarily on the concepts of service efficiency and effectiveness. For highways, engineers have traditionally used vehicle miles traveled and volume to capacity ratios for analyzing the operations of a road system. The first is not a system performance measure, and the second is difficult to apply at a network level. The concept of a composite index that is used in the HPMS Analytical Package is an attempt to better define a measure of performance that allows comparison over time and space. A current NCHRP research project on developing a congestion index is another effort to develop some measure of system performance that reduces the dimensionality of the measure such that relative comparisons can be made.

Another key issue in the definition of system performance is answering the question of "performance compared to what?" Simply listing the different characteristics of system operation (e.g., average speed, VMT, lane miles, etc.) merely permits the user to compare system characteristics with little relationship to input variables or external factors that might influence the performance of the system. The analogy to alternatives evaluation is noteworthy. The evaluation matrix which lists for each alternative the values associated with the evaluation criteria in the assessment process does not often include some measure of resource input to system output. However, during the last ten years, cost effectiveness approaches have been used to provide such a comparison. These ratios compare some level of system performance with the resources needed to achieve this performance level. In most cases, the measure of resources is dollars and the system performance relates to the major objective of the assessment. For example, cost effectiveness has been used to determine the dollar per decibel reduction in noise barrier construction; dollar per milligram of sodium chloride reduction for road drainage treatments; and, of course, in transit, dollar per new rider served with transit investment.

It is suggested that the key characteristics of performance measures are as follows. These characteristics are offered in some sense as a checklist for testing the suitability of using performance measures for comparative purposes.

1. They must be *appropriate* for the objective of the performance system. For example, if the intent of the performance system is to provide information to decisionmakers over time on where key problems exist in the system, the measures need to be defined in such a way to provide this information. This might mean a spatially disaggregated measure which could be used to pinpoint where problems exist.
2. They must be *valid* in a sense that they truly measure the underlying performance characteristics. For example, use of center line miles versus lane miles in an effort to compare effectiveness of maintenance and rehabilitation expenditures over time and between agencies could be misleading.
3. They must be *consistently defined* spatially and temporally. For example, measures of highway performance in one highway district need to be similarly defined for all other districts so that comparative assessments can be made. The same is true for comparisons over time.
4. They must *reduce the dimensionality* of the performance so that external factors cannot significantly affect the resulting value. For example, the FHWA Highway Performance Monitoring System reduces the many components of highway condition and performance into a composite index. This composite index consists of data whose basic measure is not directly affected by external factors.
5. They must be *based on data* that can be collected. For example, performance measures oriented to safety considerations need to be based on reliable accident data that can be collected. Experience in the safety area has shown that the collection of consistent accident data from many different jurisdictions is very difficult.
6. They must be defined such that *consistent data collection* in the monitoring phase is maintained. One of the problems in comparing state DOT program performance is the inconsistency in the quality and quantity of data collection from one state to another. This is particularly true for those data items that are subject to qualitative assessments of condition or performance (e.g., pavement surface conditions or ridership estimates). Even when good experimental designs and data collection strategies are used, there is still variability in the instrumentation reliability.

Input Variables: As noted previously, not all performance measurement needs to be related to resource inputs. One can conduct performance monitoring of a system simply by defining important measures (with the characteristics of measures defined above) and showing how one system compares with another. Of course, one would not be able to say "why" a system shows different performance, nor for that matter would one be able to indicate if a particular system were better than the other (unless a standard or threshold value were used). Relating performance to resource inputs primarily is aimed at determining the efficiency of resource utilization for that particular input-output production system. It is very difficult to rely on this simple relationship for comparing different systems without somehow controlling for external factors.

However, assuming that one is interested in the input-output relationship, the input variables also need to be selected with great care. The characteristics for these variables are similar to those discussed for performance measures. In most cases, the input variables are defined in dollar or personnel terms (thus, the cost effectiveness measure). However, even in this case, resources must be defined with caution. For example, transit and safety programs may be funded from highway revenue. Total highway program sums, for example, can incorporate many different expenditures, some not at all related to the ultimate performance measure of concern. In other cases, the resource variable/performance output relationship could be defined differently by various groups. A recent survey of state DOT's that was intended to determine the amount of funds directly related to encouraging economic development illustrates this point. In response to a question that asked what level of DOT funding was focused on encouraging economic development, the answers ranged from \$800 million (that is the entire DOT construction budget) to \$0. Thus, the resource variables to be used in the input/output relationship must be linked in a logical way.

External Factors: Probably the most important consideration in assuring a valid comparative assessment of similar programs is the influence of the external program environment on system performance. These factors could range from natural causes (e.g., weather-induced expenses for maintenance and rehabilitation) to physical location considerations such as being positioned along a major transportation corridor which results in heavy demands on the road system. One example of the critical significance of these factors was illustrated by New Jersey when it was shown that the costs of labor and materials can vary by a factor of two or more from state to state. A comparative assessment must incorporate or control these factors if the results can be considered valid. This can be done in different ways. Normalizing variables with respect to some dimension(s) is one way of reducing the bias. If regression analysis is being used to establish relationships, dummy variables can be used to account for unique occurrences in the data. However, the most useful approach for controlling these external factors is to cluster the program units such that the external factors are similar within each cluster. The influences on system performance when compared across clusters is therefore reduced. The most common means of doing this is through the use of peer groups.

Peer groups are used quite commonly in the transit industry. Transit agencies discovered some time ago that comparing their agency performance to all agencies, regardless of situation, produced useless information. Instead, they grouped transit systems with similar characteristics, such as metropolitan area size, size of transit system, and labor characteristics, and used this peer group as the comparative set. Even in this approach, not all extenuating circumstances can be controlled. However, it seems that establishing such clusters does provide enough control that at least some of the major external factors can be accounted for. For state highway comparisons, it makes much more sense to compare a highway program for a state like Nevada with programs in Wyoming, Utah, and New Mexico, than it does to compare it with programs in Massachusetts, Pennsylvania, or New Jersey. The identification of factors most important for this clustering is critical and is an important research issue.

4.3 National Quality Initiative

A major national initiative called the National Quality Initiative (NQI) was launched in 1992. The charter members include the Federal Highway Administration, the American Association of State Highways and Transportation Officials, the American Road and Transportation Builders Association, the Associated General Contractors of America, the American Concrete Pavement Association, the National Asphalt Pavement Association, the National Ready Mixed Concrete Association and the American Consulting Engineers Council. The purpose of the NQI is to establish a partnership of Federal, State and industry highway officials to ensure that our nation's highways provide the highest quality facilities and services for the safe and the most cost-effective mobility possible. This is also necessary to ensure that we maintain economic competitiveness in the global market place. FHWA and AASHTO have established as a high priority the need to take quality to the highest plateau possible.

An important element in achieving the major objectives of "total quality management" (TQM) is the need to establish highway performance measures that can be used as benchmarks to determine the quality of state highway programs. The TQM process requires the development of an effective partnership with one's customers. Consistent with this process would be involving the customers of the state highway program in the selection of the performance measures. As this process suggests, it is entirely possible that many of the measures would vary from state to state, within regions, or many areas within a single state (e.g., urban vs. rural areas). The importance of this requirement in the TQM process is in reflecting the customer's values in the performance evaluation process and to recognize that there will, in all likelihood, be significantly different priorities among the 50 states. Some states (Minnesota, for example) have already begun the difficult task of establishing various standards and "measures" that will be used to make periodic evaluations of highway program performance.

The research undertaken by this project leads the authors to conclude that a concerted effort should be launched by the state DOT's, perhaps through appropriate AASHTO Committees, to develop an appropriate follow-up effort that will build upon the conceptual framework suggested in this chapter. A commitment has been made by FHWA and the states through the NQI to develop more explicit programs aimed at total quality management. We trust that this report will provide some assistance in launching such an effort.

4.4 Potential For Highway Program Monitoring In The Future

This report has stated that there is an important need for a good methodology to assess the performance of highway programs. Such a methodology should be a critical element of good management. If the methodology is developed carefully and in a meaningful fashion, it can produce important information on the trends in program performance over time, and in comparison with state peers. The Intermodal Surface Transportation and Efficiency Act (ISTEA) provides a great opportunity to establish such a program monitoring capability in every state. The ISTEA mandates that every state develop a statewide congestion management system and an intermodal management system. The Metropolitan Planning Organization's (MPO) will be developing a congestion management system for urban areas. Although not yet in place, and in some cases not yet defined, these management systems offer promise for producing the type of information that can feed into effective program performance monitoring. The results of two national meetings on congestion management and one on intermodal management systems indicates that this potential does exist.

During one of the congestion management workshops, participants identified six elements that, at a minimum, constitute a congestion management system. These elements were:

- Identification of Targeted Systems or Areas;
- Identification of Performance Measures;
- On-Going Data Collection and System Monitoring;
- System Performance Evaluation Process;
- Congestion Reduction Strategy Identification and Evaluation; and
- Implementation.

Two characteristics of this approach that relate to program assessment include the emphasis on performance measures, data collection, and system monitoring. There was considerable discussion on the desirability of performance measures and the development of a congestion index. Most of the participants felt that a limited number of performance measures, defined by state and local officials, should be the basis for determining progress in achieving performance objectives. These performance measures should measure the extent, severity, and duration of congestion and the reliability of system performance. A congestion index was considered to probably be useful for national comparisons, but participants felt that it was too broad to be of much use to state and local officials.

Two major types of data are required to make a congestion management system work: data on system performance and evaluation data on actions implemented. These data need to address people and goods as well as vehicles. The data on system performance would clearly be related to the types of performance measures adopted in the above step, and would likely have to be more sensitive than today's data to such things as on-time performance, speed, queues, and other performance characteristics. Of some importance in this regard are data on non-recurring congestion. In addition, the participants felt that implementing agencies will likely play a critical role in collecting the data for the system monitoring function.

The key point surfacing from this workshop was that a fundamental basis of a congestion management system was the measurement of system performance. Identifying performance measures will not be easy, and yet by doing so the planning process could very well take a step closer to becoming a program management strategy.

A recent conference on intermodal management systems provides additional linkages to program assessment. Once again the emphasis on performance measurement is a key issue. The focus of intermodal planning is on improving the performance of the intermodal transportation system. As was pointed out by many of the conference participants, some of the key bottlenecks in moving from one place to another, for both passenger and freight transportation, occur at connection points, e.g., terminals, ports, airports, transfer stations, and the facilities leading to them. The participation of private sector groups in the intermodal planning and decision making process provides added importance to the concept of defining and monitoring system performance. These groups in particular need to see the benefits that will occur by their participation and by the consequences of the decisions that are made. The implication of this emphasis on performance is that intermodal planning and, especially, intermodal management systems, should be based on a set of system performance measures. These measures should allow some sense of how the system is doing over time and where problems exist. Some example performance measures include:

- Level of service
- Quality of travel
- Travel cost
- Convenience
- Safety
- Reliability
- Flexibility for accommodating additional intermodal travel

The conference participants identified a list of possible performance measures and concluded that some would probably be more important than others. In some cases, measures could be combined into one factor, for example, an intermodal mobility index.

The following elements of an intermodal management system were considered as desired elements of a system. The basic elements of an intermodal management system include:

- inventory of modal/intermodal elements including institutions, markets, operations, and physical plant;
- identification of an "intermodal system" that becomes the focus of the intermodal management system;
- use of performance measures that will allow some sense of how the system is doing over time and where problems exist;
- identification of strategies and actions that will improve intermodal transportation efficiency and effectiveness, including non-investment options such as pricing, regulatory changes, etc.;
- analysis and evaluation of these strategies/actions from the perspective of intermodal concerns, e.g., economic value to system users, cost, improvement to system interconnectivity, etc.;
- establishing priorities among strategies/actions within the context of overall planning effort; and
- mechanisms for including users and providers in this process (e.g., advisory groups).

The ISTEA requires that states and MPO's develop six management systems. Given a working definition of management systems (designed to provide information for decision making), it is important that these six be integrated in such a way that maximizes the usefulness of the information provided. There are clear overlaps among the different management systems. These include:

- Cross referencing of data (e.g., bridge conditions)
- System definitions
- Policy tradeoffs that would affect more than one system
- Performance measure definition
- Database management coordination/relational database

- Users of systems
- Economic benefits/costs

Of particular interest in the discussion was the interrelationship between the intermodal and congestion management systems. Intermodal management systems are applied on a larger scale, that is the state, with the intent of improving the connectivity of the system. Clearly, many of the connection points and thus the locations of "hot spots" for the intermodal system will be in urban areas. Therefore, designers of both management systems need to be especially careful in interrelating the two systems. The development of ISTEA-required management systems is a unique opportunity to put in place a system performance program that provides a consistent and valid information base. These data would prove invaluable for program assessment.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The intent has been to provide a synopsis of reports and other literature found to be pertinent to the charge of the study, and this paper has reviewed various approaches to comparative performance. In all instances the use and quality of data were recognized as critical factors in the results obtained and in their use. Although this is not an unexpected observation, it is useful to note the widespread recognition of its importance. The observation reinforces the basic premise fundamental to every researcher, and that is to understand, with recognized confidence, the character of each data element to be used in any rigorous analysis. This should include an understanding of the data collection technique, what it is intended to represent, and the confidence limits associated with its recorded value.

Many similar key issues were identified as important to an impartial study of state highway performance:

- there are numerous uncontrollable and inconsistent factors affecting state-by-state comparisons which cannot be accurately or adequately captured by a single measure;
- there may be merit in making comparisons of specific program areas such as pavement conditions, bridges, levels of congestion, etc.;
- great care must be taken to insure that the statistics used to make any comparison are consistent and accurate (e.g., the California study);
- variables used in "resource allocation" may be significantly different from state to state (i.e., New Jersey includes labor and materials);
- any state-by-state comparison must consider unique factors such as variation in costs (e.g., New Jersey vs. California), priorities (e.g., pavements vs. bridges or capital expenditures vs. maintenance or prevention vs. routine maintenance);
- care in the use of data for varying levels of analysis (i.e., macro vs. micro levels; internal use vs. external comparison); and
- the issue of comparative evaluation is further complicated by defining satisfactory performance.

If state-by-state comparative analyses of highway program performance are to be undertaken, then the states must be requested to obtain and report more micro-level data that are consistent and reliable. This could be a very huge task, unless it becomes part of the development of, and reporting on, the six management systems required by ISTEA.

Before recommending that such large scale evaluations be established, we need to be certain we know what will be done with such analyses once they have been accomplished. If undertaken, they must be done in a way that will assist the state highway agencies in doing a better job of managing their programs. If not carefully designed, such comparative

analyses could be used in a punitive way, be viewed very negatively and be counter-productive. This latter situation would result in states designing their programs to be certain that the "right" statistics are produced. It would not at all measure or indicate "value received" for resources expended if that were the case.

If we look at the HUF reports carried out for over a dozen states, they always include some state legislative committee or transportation commission. By definition, there is significant input by political leaders in the state, thereby contributing to the concept of accountability. That kind of in-depth analysis of substance and politics seems to be the right combination. It is not clear that a state-by-state comparison of such studies would be useful or relevant if one were to "rank" the states numerically.

With the exception of the UNC/Charlotte report and possibly the HPMS analysis, we have found no examples of state-by-state rankings or state-by-state comparisons of highway program performance. We have concluded that at this time it is not possible nor is it appropriate to develop composite ratings of state highway programs, because neither the analysis methodologies nor the appropriate data are available to do so. It is particularly inappropriate to make any attempts to rank states (1 through 50), because the data do not exist that allow one to do so. Further, given the current availability of data, or lack of appropriate data, it is not reasonable or feasible to consider developing such rankings in the near future. Even if expensive and laborious data collection and analysis procedures were established to accomplish such an objective, the value of doing so is questionable.

There are, however, potentially significant benefits to be derived when individual state programs and methodologies are established to develop performance measures that serve state management needs and those of their customers. If acceptable state performance standards are established, then performance measures should be used periodically to evaluate a state's highway program accomplishments. If "peer state" reviews can be made using the same performance measures, then some useful comparisons are possible. Our "conceptual framework for program assessment" provides a starting point for accomplishing the objectives desired for relevant and appropriate comparative measures.

ANNOTATION OF RELEVANT LITERATURE

TITLE Evaluating the Efficiency of Nonprofit Organizations: An Application of Data Envelopment Analysis to the Public Health Service

AUTHOR Vicente Pine and Lourdes Torres

JOURNAL Financial Accountability and Management

ABSTRACT

The usefulness of the data envelopment analysis (DEA) model as a management tool when applied to the measurement of the efficiency of health centers (namely, the new health centers being introduced by the Spanish National Health Service) is evaluated. The DEA model is chosen because it does not require prior specifications, which could be useful when there is a lack of data on costs. The evaluation of global efficiency provides valuable information on the effect of size with respect to the health center. The 4 globally efficient centers have a lower population level than the others, but their consumption of inputs is similar to those centers that have been shown to be inefficient. Their efficiency is a result of the maintenance of a higher level of activity; they have been able to capture and keep the population as clients of the public health service. Taking full advantage of the information that might be provided by the DEA method will be useful only in the context of decisions that are taken in a decentralized manner.

TITLE Sensitivity Analysis for DEA Models: An Empirical Example Using Public versus NFP Hospitals

AUTHOR Vivian Valdmanis

JOURNAL Journal of Public Economics

ABSTRACT

The data envelopment analysis (DEA) is applied to a sample of public (government-owned) and not-for-profit hospitals operating in Michigan in 1982. The focus of this research is twofold. First, assessing the relative efficiency between these 2 ownership types using the DEA rather than costs or profit functions can add insights into the production practices of these 2 ownership forms of hospitals. Second, testing the sensitivity of the DEA will add credence to this approach and resulting measures. Ten different specifications of the DEA are employed to test the sensitivity of the model. Public hospitals in the sample were relatively more technically efficient than not-for-profit hospitals. These results were not altered when the model specification was altered, therefore the model is considered robust.

TITLE Measuring the Efficiency of the Logistics Process

AUTHOR Richard L. Clarks and Kent N. Gourdin

JOURNAL Journal of Business Logistics

ABSTRACT

The efficiency of the logistics process has been of interest to business for a long time. It has become increasingly important in the decade of the 1980s with growing global competition and reduced government regulation. The use of a management science model called Data Envelopment Analysis (DEA) is explained. DEA is designed to aid logistics managers in their efforts to measure logistics efficiency and identify weaknesses. The findings in a case study conducted with 17 vehicle maintenance organizations over a 4-year period indicate that DEA can help measure the relative efficiency of the logistics process and that nontechnical managers can understand and apply DEA in their organizations. DEA also was found to have some valuable implications for international logistics managers.

TITLE A Methodology for Collective Evaluation and Selection of Industrial R&D Projects

AUTHOR Muhittin Oral, Ossame Kettani, and Pascal Lang

JOURNAL Management Science

ABSTRACT

A methodology is proposed for evaluating and selecting research and development (R&D) projects in a collective decision setting, especially useful at sectorial and national levels. The methodology consists of 2 major phases: evaluation and selection. The evaluation process repeatedly used mathematical programming models to determine the relative values of a given R&D project from the viewpoint of the other R&D projects. The selection process of R&D projects is based on these relative values and is done through a model-based outranking method. The salient features of the methodology are its ability to: 1. permit the evaluation of an R&D project from the viewpoint of the other R&D projects without at first imposing a uniform evaluation scheme, and 2. maximize the level of consensus as to which projects should not be retained in the R&D program being funded, thus minimizing the level of possible resentment in organization or department whose projects are not included in the R&D program.

TITLE Efficiency Considerations in the Social Welfare Agency

AUTHOR Joseph Heffernan

JOURNAL Administration in Social Work

ABSTRACT

Professional social workers and other staff members are often in conflict with administrators over the right place for the use of efficiency criteria. The efficiency criterion is based on net return to investment and assumes that all appropriate costs and benefits can

be tabulated. The efficiency criterion assumes that efficiency is an unambiguous good. Consistent use of normative modifiers attached to the term "efficiency" is one way that a mutually dependent and consistent set of perspectives with regard to the place and value of efficiency can be formed. Efficiency is judged and measured in a variety of contexts. Data Envelopment Analysis (DEA) is a procedure for the measurement of instrumental efficiency in nonprofit contexts. In DEA analysis, neither the output nor the input needs to be measured in dollar terms. The entities responsible for committing inputs in pursuit of outputs are called decision-making units (DMU). Each DMU can be ranked relative to all others without regard to budget constraints.

TITLE Profit Incentives and Technical Efficiency in the Production of Nursing Home Care

AUTHOR John A. Nyman and Dennis L. Bricker

JOURNAL Review of Economics and Statistics

ABSTRACT

During recent years, nursing home expenditures have approached 1% of gross national product. Their growth is a major contributor to the escalating costs of health care. A sample of 184 Wisconsin nursing homes was analyzed to determine the characteristics of efficiently operated nursing homes. Data envelopment analysis is used to calculate efficiency scores for the various nursing homes in the sample. Then, regression analysis is used to investigate the determinants of efficiency, holding constant the characteristics of the output. The evidence suggests that for-profit nursing homes have significantly higher efficiency scores. An for-profit home used about 4.5% fewer labor resources per patient day than a nonprofit home. Homes with higher short-run occupancy rates also have higher efficiency scores.

TITLE Using Data Envelopment Analysis to Measure the Efficiency of Not-for-Profit Organizations: A Critical Evaluation

AUTHOR T. Ahn, A. Charnes, W. W. Cooper, and Thomas R. Nunamaker

JOURNAL Managerial and Decision Economics

ABSTRACT

Nunamaker (1985) addresses inadequacies in data envelopment analysis (DEA) as a method for: 1. measuring efficiencies of not-for-profit entities identified as decision-making units (DMU), and 2. locating sources and amounts of inefficiencies in each of the inputs utilized and in each of the outputs produced by each DMU. Nunamaker's interpretation of the concept of Pareto-Koopmans efficiency as presented by Charnes et al. (1978) for use in DEA is erroneous and seriously affects Nunamaker's presentation. Nunamaker's central proposition is that, when a DMU has been accorded efficient status by DEA, introducing a new variable will not alter this previously achieved efficient status. This proposition is erroneous, as illustrated through example. In reply, Nunamaker emphasized that he did not intend to examine all facets of DEA in his analysis.

TITLE A Generalized Multiple Criteria Model for Control and Evaluation of Nonprofit Organizations

AUTHOR Robert Greenberg and Thomas Nunamaker

JOURNAL Financial Accountability and Management

ABSTRACT

The Data Envelopment Analysis (DEA) approach developed by Charnes, Cooper, and Rhoads (1978) represents a technique by which noncommensurate multiple inputs and outputs of an entity can be objectively combined into an overall measure of organizational performance. However, most managerial control schemes in nonprofit organizations utilize a ratio approach using several ratio measures that must be aggregated into an overall evaluation of performance. Here, a compromise is sought between the conceptually appealing DEA methodology and the more widely used ratio approach. Specifically, the DEA approach is generalized to broader situations by viewing it as a multiple criteria control model, wherein each criterion represents a familiar performance ratio. In this manner, the ratio and DEA approaches are merged while retaining the relative strengths and advantages of each. Incorporation of conventional performance measures and ratios should promote practical acceptance of the DEA methodology because this formulation more closely models the decision maker's evaluation problem.

TITLE Evaluating Performance in Governmental Organizations

AUTHOR William F. Bowlin

JOURNAL Government Accountants Journal

ABSTRACT

Many governmental organizations face the problem of allocation of scarce resources so as to maximize public benefits. In the private sector, the market mechanism provides an indicator of the effectiveness and efficiency of the organization. In government, there is no "market" for its outputs. This leaves a combination of judgment and input costs minimization for use in the search for optimum performance. Research involving a way for governmental organizations to evaluate their efficiency is reviewed. Areas discussed are: 1. research development, 2. data envelopment analysis (DEA), 3. prototype environment, and 4. evaluation of Air Force real property maintenance activities. The DEA is an external methodology to computer a relative measure of efficiency in comparison with the most efficient organization in an evaluation set. The DEA system is similar to standard cost accounting systems used in commercial enterprises. Further DEA research will probably lead to new ideas and types of analysis for evaluating government performance.

TITLE Improving the Productivity of Service Businesses

AUTHOR H. David Sherman

JOURNAL Sloan Management Review

ABSTRACT

Data Envelopment Analysis (DEA), a linear programming technique, can be used to: 1. compare the productivity of similar service organizations, 2. identify inefficient operations, and 3. provide ways to reduce inefficiencies. DEA, best used by firms using multiple resources to produce multiple services, has been successfully applied to banks, hospitals, and customer service organizations. DEA uses a comparison of inputs with outputs to develop a set of relative efficiency ratings. DEA also calculates the relative value of inputs and outputs to provide management with a basis on which to improve inefficient operations. DEA, when applied to a set of teaching hospitals, identified inefficient hospitals that other productivity-measuring techniques had failed to identify. When applied to 14 branches of a savings bank, 6 branches were found to be inefficient. In both cases, DEA provided input and output data that helped management take action to improve productivity. DEA can be applied using successive time periods to control efficiency over time and complement other management control techniques.

TITLE Measuring Managerial Efficiency in Rural Government

AUTHOR Steven C. Deller, Carl H. Nelson, and Norman Walzer

JOURNAL Public Productivity and Management Review

ABSTRACT

A method is presented for assessing the efficiency of producing local public services that seeks to incorporate microeconomic theory into the measurement process. The method is illustrated using the case of producing low-volume rural road services in the Midwest. A statistic comparing the ordinary least squares estimate and the maximum likelihood estimate of the cost function is significantly different from zero at the 95% level of confidence. The findings imply that managerial inefficiencies exist in the Midwestern rural road data. On average, nearly 45% of rural road expenditures may be unnecessarily incurred due to managerial inefficiencies. The results also indicate that cost savings from economies of scale and from a reduction in managerial inefficiencies may be realized through consolidation of production-related responsibilities.

TITLE The State of the States

AUTHOR Katherine Barrett and Richard Greene

JOURNAL Financial World

ABSTRACT

Financial World examined the state of business in the 50 US states and ranked them according to their performance in 9 areas: 1. accounting and financial reporting, 2. revenue estimations, 3. expenditure estimation, 4. rainy day funds, 5. other budgeting issues, 6. program evaluation and performance measurements, 7. pensions, 8. bond ratings, and 9. infrastructure controls. States earned low places in the rankings by spending money that they do not really have. Virginia was ranked number one, up from number 4 in 1991. The state has good long-range planning, quick adjustment of errors in revenue estimates, accurate estimates of Medicaid and corrections expenditures, and excellent and multifaceted

program evaluation. Further, Virginia achieved a balanced budget in current year on cash basis with no major new taxes. Wyoming was ranked 50th because of its serious expenditure-revenue imbalance, drained general fund balance, and its lack of performance measurements.

TITLE Making Government "Profitable"

AUTHOR David J. Harr and James T. Godfrey

JOURNAL Management Accounting

ABSTRACT

A 1988 Executive Order mandated a program to improve the quality, timeliness, and efficiency of services provided by the federal government. A study was undertaken to examine financial and related performance measure used by private sector service-oriented organizations and how they could be applied to government operations. The study focused on logistics operations to assess the applicability of both traditional and more recently developed techniques from businesses in an actual government operation, the Department of Defense Depot in Mechanicsburg, Pennsylvania. Seven major principles for effective development and use of cost-based financial performance were employed at the depot: 1. Use output-oriented measures. 2. Identify total costs of service delivery. 3. Take an operational view of costs. 4. Use measures relating total costs. 5. Provide incentives for financial and operating performance. 7. Improve quality and timeliness of service delivery.

TITLE Public Productivity Measurement: Diseases and Cures

AUTHOR Geert Bouckaert and Walter Balk

JOURNAL Public Productivity and Management Review

ABSTRACT

In discussions about productivity measurement, there has been a shift from a belief in the power of quantified measures to an awareness of their dysfunctional effects, and there has been a shift in discussion from the meaning of management to the management of meaning. The 13 "diseases" in measuring productivity in a management context can be divided into 3 groups: 1. those associated with the assumptions of measurement, not with measurement itself, 2. those associated with perceived numbers and volumes, and 3. those concerning the content, position, and amount of measures. Managers in the public sector need to direct more attention toward the extrinsic requirements, that is, the impact on the organization of the use of measurement. They must search for optimal measures that minimize dysfunctional effects and maximize functional effects, allowing managers to focus on the extrinsic requirements of the organizational purpose.

TITLE Tailoring Performance Measurement to Fit the Organization: From Generic to Germane

AUTHOR Mark Glaser

JOURNAL Public Productivity and Management Review

ABSTRACT

the issues faced in the design and implementation of performance measurement in Wichita, Kansas, are examined. Six issues that are important hurdles for efforts to make performance measurement germane to decision making are: 1. triangulating measures for valid assessments of performance, 2. establishing targets for improved performance and human resource planning, 3. linking performance measurement to strategic planning, 4. integrating management information with resource allocation, 5. defining the appropriate level of flexibility in performance reporting, and 6. defining and reducing resistance to performance measurement. The experiences of Wichita in the design and implementation of performance measurement provide empirical evidence for performance measurement validity, practical application of performance targets, the integration of strategic planning, budgeting, and performance measurement, flexibility in reporting formats, and reduction of resistance to performance measurement.

TITLE Performance Measures for State Highway and Transportation Agencies

AUTHOR M. Reed

SPONSOR AASHTO and FHWA

ABSTRACT

The specific objective of this project is to produce a compendium of performance measures and indicators to assist state highway and transportation department and their CAOs in evaluating and continuously improving the operational performance of their agencies. This compendium will include performance measures and indicators most commonly used by individual states and provide a recommended composite lists of measures and indicators with synthesized definitions that could be acceptable to a large number of states. It is recognized that there are many terms and secondary performance indicators that an agency may use. The contractor should focus on those that appear to be most common. The purpose here is not to develop new performance measures or indicators, but rather to identify, collect, and categorize measures by transportation mode.

TITLE Engineers as Strategic Managers: Performance Assessment

AUTHOR W. E. Hopkins

JOURNAL Journal of Management in Engineering

ABSTRACT

This is an attempt to empirically test the effectiveness of engineers as strategic managers, as measured by the economic performance of the organizations they direct. Although it is not

possible to precisely test the degree to which occupational loyalty and a narrow task-oriented perspective restrict the effectiveness of engineers as strategic managers, it could be stated that these characteristics are inconsistent with the responsibilities ascribed to strategic managers. An analysis of organizations from three different industries showed that organizations directed by business-oriented strategic managers performed consistently better, and in one industry significantly better, than organizations directed by engineering-oriented strategic managers.

TITLE Port Authority Improves Productivity Through PMP

AUTHOR H. Schmerl

JOURNAL Public Works

ABSTRACT

The Engineering Design Division of the Port Authority of New York and New Jersey has instituted a productivity improvement program to use its resources more effectively and efficiently. This program is known as the Participative Measurement Process (PMP). Like most productivity programs, PMP's objectives are to maximize unit efficiency and productivity through tracking, analyzing, and corrective actions regarding key performance indicators (or measures). This article discussed the PMP process, performance measures, the nine categories selected to be used as the basis for the Family of Measures, the measurement system, the Engineering Design Division's organization, and the results of the program. Problems uncovered and recommendations for solving them are presented in conclusion.

TITLE International Transit Performance Measurement -- Case Studies

JOURNAL Public Technology

ABSTRACT

This report contains three case study papers prepared for a seminar held on September 8, 1980. Described in detail are performance evaluation concepts and programs in France, Germany, and the U.S. Each paper described the institutional structure within which transit performance is conducted, the underlying concepts and philosophy on which evaluation is made, the goals and objectives of evaluation, typical performance indicators used for analysis, methodological and attitudinal problems, and statistical trends in transit performance as measured by productivity indicators. The U.S. case study examines transit performance on the federal, state and metropolitan planning organization (MPO) level. Prepared for a seminar held on behalf of the German Marshall Fund.

TITLE Transit Performance Measures: Applications for the Minnesota Department of Transportation

AUTHOR W. M. Lyons

SPONSOR Minnesota Department of Transportation

ABSTRACT

A-9 A-10

This report examined ways in which the Minnesota Department of Transportation (MnDOT) might use performance measures to increase the productivity of twenty-five rural and small city transit systems supported by the state. The author isolates five problem areas that impede the productivity of the state's transit operators, suggesting that these may be improved through the application of transit performance measures. He recommends that MnDOT develop and implement an integrated system of goal-setting, performance targets, project evaluation, and performance-based financial incentives as an alternative to the existing transit subsidy process which is non-performance based. An evaluation program utilizing standardized measures of transit performance is proposed. The author recommends that MnDOT use financial incentives to reward performance that surpasses established standards. As an alternative to retention of funds for substandard performance, MnDOT could replace funds with technical assistance.

TITLE

General Theory and Technique for Measurement of Organizational Communications and Program Effectiveness

AUTHOR

H. I. Shaller

JOURNAL

Hawaii International Conference on System Sciences

ABSTRACT

Discussion of generalized analytical system structure developed for measuring organizational communications and program effectiveness when set of organizational goals and objectives are specified and organization activities are identified.

TITLE

RANN Utilization Experience. Case Study No. 10. Effectiveness Measurement Methods

AUTHOR

H. P. Harry

SPONSOR

Research Triangle Institute

ABSTRACT

The Urban Institute's RANN project, Effectiveness Measurement Methods, is designed to help satisfy the need for substantive information on the effects of government services on citizens and the community. The lack of this information has limited the ability of local officials to evaluate services, allocate resources, and formulate policy. The objectives of the study were to develop the tools and an implementation system that would afford local officials significantly improved information on their services; specifically, the measure were intended to help identify current problem areas, indicate progressive or retrogressive trends, indicate inequities in service delivery, provide a data base and methods for its use in productivity-incentive plans, and provide a data base for use in comparison research between cities. Cities throughout the nation are adopting the techniques derived in this project. The techniques are readily modifiable for almost any local government.

TITLE

Measuring the Effectiveness of Local Government Services: Transportation

AUTHOR

R. E. Winnie and H. P. Hatry

SPONSOR

Urban Institute

ABSTRACT

A consumer-oriented approach is made to assessing the quality of local transportation. The authors propose a system that local governments may use to estimate how well their transportation-related services are serving their citizens. Twelve specific measures of effectiveness, keyed to such broad goals as accessibility, convenience, travel time, safety, and maintenance of environmental quality, are proposed. Ways to collect and analyze the necessary data are indicated. Summary recommendations and cost estimates for carrying out the measurement system are provided.

APPENDIX B

ANNOTATION OF SELECTED REPORTS

Outline of Reports Selected For Inclusion in This Study

The purpose of this Appendix is to provide a brief outline of the reports obtained during the research for this project. The following outline is used for each, when possible:

1. State (where appropriate)
2. Report title, date, author(s), and contact persons (where appropriate)
3. Purpose
4. Methodology used
5. Factors/criteria used to evaluate state programs
6. Application of results to a state (or states)
7. Potential applications to compare state programs
8. Comments/observations/critique

STATE

NCHRP Report: Nationwide Analysis

TITLE

Measuring State Transportation Program Performance: Final Report

DATE

November 1992

PREPARED BY

NCHRP/HUF

CONTACT

Marshall F. Reed

PURPOSE

To isolate and describe the key program performance measures and indicators needed by all administrative officers of state highway or transportation departments in administering state transportation programs.

METHODOLOGY

A survey questionnaire was sent to all state DOT's to gain a national consensus of:

1. A set of program performance measures for evaluating the effectiveness and efficiency of state transportation programs.
2. A set of internal management factors that should be used in managing state programs.

Most states do not measure either of the above indicators in any systematic way. Many data items are collected, but they are not suitable for evaluating state performance. The closest measure of performance may be the evaluation of bridge condition. HUF also noted a "lack of goals or benchmarks" for measuring performance.

FACTORS/CRITERIA USED

Based upon the survey results, the following factors/criteria were used to evaluate state programs:

- Details of the highway system
- Highway program costs
- Highway needs and conditions
- Highway improvements
- Highway safety and risk management
- Mass transit service use and cost
- Air transportation
- External factors
- Financial data
- Improvement programs
- Human resources

APPLICATION OF RESULTS TO A STATE

The data were obtained from 42 states, the District of Columbia and eight Canadian provinces. The results were used to form the conclusions summarized below.

POTENTIAL APPLICATIONS TO COMPARE STATE PROGRAMS

The study concludes that it is not possible at this time to realistically compare the performance of state DOT's. This is because there is a clear absence of consistent information for doing so. However, the study concludes that there is a need to develop methods for doing so.

COMMENTS/OBSERVATIONS/CRITIQUE

This is probably the most comprehensive analysis of the performance of state highway programs conducted to date. It provides a significant amount of new information. But it also identifies major data deficiencies in the attempt to accomplish the study objectives. The report concludes that it is not possible at this time, given the absence of relevant data, to make state-by-state comparisons.

STATE

Alaska

TITLE

An Evaluation of the Management of the Alaska Highway Program

DATE

December 1987

PREPARED BY

Highways Users Federation

CONTACT

M. Clyde Stoltzfus

PURPOSE

To evaluate the effectiveness of Alaska's total highway program in meeting its citizens' needs for safety, service and cost-effective transportation now and in the future.

METHODOLOGY

This is a typical HUF evaluation, covering many management, finance, needs, performance and productivity issues.

RELEVANCE TO NCHRP STUDY

As in the case of each of the HUF reports, this contains a chapter on "Productivity" which compares Alaska to other states. Each report also identifies the state differences concerning demographic, financial, geographic, etc. characteristics.

See New Hampshire Summary

STATE Arkansas
TITLE 1992 Selected Facts and Figures
DATE 1992
PREPARED BY Arkansas DOT
CONTACT Roger Almond

PURPOSE

To compare Arkansas highway data to all other states.

METHODOLOGY

This study summarized the FHWA Highway Statistics in several categories. It shows how Arkansas compares with all other states. No analysis is made, and no comparisons are made.

STATE California (1)
TITLE Cost of Developing Highway Projects
DATE May 1992
PREPARED BY Caltrans
CONTACT Allan H. Hendrix
 Deputy Director, Transportation Planning, Caltrans

PURPOSE

To analyze the procedures used to report project development costs by California and other states. It was in response to severe criticism leveled at Caltrans based upon a published report stating that California's average annual cost of engineering exceeds 44% of total capital outlay. This was compared to a national average of 15% for all states combined.

METHODOLOGY

In September, 1991, the "Professional Services Management (PSM) Journal" published a report titled "The Effect of Contracting Out On Engineering Costs." This report was prepared for the American Consulting Engineers Council and was developed from data submitted annually by the states to the FHWA. Because of the criticism, Caltrans prepared its own analysis of the cost of developing highway projects. The report compared the methods used by five other large states (Florida, Illinois, New York, Pennsylvania and Texas). Their report concluded that the California costs averaged 16.5% over the last three years when using consistent data and methodology. It concluded that the 1991 PSM Journal article's study methods and data used to compare states were flawed and led to inaccurate conclusions.

FACTORS/CRITERIA USED

The Caltrans study showed that the FHWA statistics used as the basis for the PSMJ study cannot be used to accurately compare California's engineering costs with other states because numerous items are included in California's engineering costs that may or may not be used by other states in their cost calculations. Caltrans surveyed 14 other state DOT's to form this conclusion. The differences in cost calculations included whether or not items were included such as administrative expenses, construction engineering, employee benefits, special-funded programs, internal service centers, time period included in the computations, etc.

APPLICATION OF RESULTS TO A STATE

The Caltrans analysis identified a number of flaws in the comparative analysis prepared by the PSM Journal. This was shown to be covered by a number of significant inconsistencies reported to FHWA by the states.

POTENTIAL APPLICATIONS TO COMPARE STATE PROGRAMS

This analysis provides some valuable insights into the pitfalls associated with comparative analyses, based upon a simplistic acceptance of data reported for purposes other than another intended use.

COMMENTS

An exchange of correspondence between Caltrans, FHWA and the PSM Journal, together with the Caltrans report raises important relevant issues concerning why inconsistencies in data reporting can lead to flawed conclusions.

STATE

California (2)

TITLE

A Cost Comparison of Contracting Out For Engineering Services by Caltrans, versus In-house Engineering (310 Pages)

DATE

June 30, 1992

PREPARED BY

University of California at Berkeley

CONTACT

Allan H. Hendrix
Deputy Director, Transportation Planning, Caltrans

PURPOSE

To compare the cost of contracting out engineering services, with the costs of performing those services with in-house forces. This was the more detailed study requested by Caltrans in response to the criticism that the costs of in-house project development by Caltrans averaged 44% of capital costs; this was about three times the national average of 15% by all other states.

SUMMARY

The study collected detailed cost data for highway projects designed by in-house Caltrans personnel and for projects designed by outside contractors. The average costs of the projects showed that there was no significant differences between the cost to design a project in-house compared to the cost of contracting for those services.

RELEVANCE TO NCHRP STUDY

The study did reveal that there are inconsistencies in data reporting and in methodologies used to utilize comparable performance measures.

STATE Idaho
TITLE An Evaluation of the Idaho Highway Program
DATE April 1985
PREPARED BY Highways Users Federation
CONTACT Keith E. Longenecker

PURPOSE

To evaluate the effectiveness of Idaho's total highway program in meeting its citizens' needs for safety, service and cost-effective transportation now and in the future.

METHODOLOGY

This is a typical HUF evaluation, covering many management, finance, needs, performance and productivity issues.

RELEVANCE TO NCHRP STUDY

As in the case of each of the HUF reports, this contains a chapter on "Productivity" which compares Idaho to other states. In addition, the report also identifies the state differences concerning demographic, financial, geographic etc. characteristics. No state-by-state comparisons are made.

See the New Hampshire DOT summary for more detail on HUF studies.

STATE Kansas
TITLE Management, Organization and Staffing Findings and Recommendations
DATE November 9, 1992
PREPARED BY Peat, Marwick, Main & Co.
CONTACT Deb Miller, KNDOT

PURPOSE

To assess and present recommendations to strengthen the management policies and practices, the organizational structure and staffing of KNDOT.

METHODOLOGY

This report is similar to those prepared by HUF. The analysis included a peer review of practices in three states (Iowa, Nebraska, Oklahoma), and interviews with state personnel. The conclusions indicated that KNDOT appears to be comparable to "peer" states, but no analysis is undertaken to analyze similarities or differences.

RELEVANCE TO NCHRP STUDY

Same as for HUF reports.

STATE Maryland (1)
TITLE Maryland's Highway System Compared to Other States
DATE August 1992
 Revised October 29, 1992
PREPARED BY Md DOT
CONTACT Neil J. Pedersen

PURPOSE

To compare Maryland to other state performance levels and expenditures.

METHODOLOGY

Uses FHWA data to show how Maryland ranks relative to other states. There are some significant statistics that relate "demand" (congestion, urban concentration, etc.) to performance.

RELEVANCE TO NCHRP STUDY

This report emphasizes that there are very unique state characteristics that must be considered in making state comparisons.

STATE Maryland (2)
TITLES (a) Maryland Highway Program Review By HUFSA
 (b) Md SHA Program Review
DATES (a) October 26, 1992, and August 24, 1992
 (b) September 4, 1992
CONTACT Clyde E. Pyers and N.J. Pedersen

PURPOSE

To compare costs of highway program design, construction, maintenance and operation to eight other states.

METHODOLOGY

Statistics were obtained from HUF and FHWA. The data show very favorable comparisons of Md DOT to other states. This report also points out inconsistencies in data reporting which makes state by state comparisons very difficult.

RELEVANCE TO NCHRP STUDY

Data reporting inconsistencies make it very difficult to make comparisons between states.

STATE Nebraska

TITLE Report to the State Board of Equalization

DATE May 16, 1986

PREPARED BY Nebraska Department of Roads

CONTACT R.H. Hogrefl
Director, State Engineer
(There was no transmittal letter)

PURPOSE

To answer the question posed by the Governor, "Why is the Nebraska gas tax so high?"

METHODOLOGY

Compares fiscal, demographic, mileage and condition statistics to six surrounding states.

RELEVANCE TO NCHRP STUDY

This study shows that the "raw statistics" (such as the amount of the state gas tax) does not tell the whole story. Nebraska has the highest gas tax, but the lowest price at the pump for gasoline purchases. Nebraska's pavement condition is better than that of the surrounding states, but the gas tax is also used to support other state functions (i.e. other than highways). This illustrates that raw statistics may sometimes compare "apples with oranges."

STATE New Hampshire

TITLE An Evaluation of the Management of the New Hampshire State Highway Program

DATE 1990
October 19, 1990 (Transmittal letter)

PREPARED BY Highway Users Federation
Washington, D.C.

CONTACT Marshall F. Reed, Sr.

PURPOSE

The purpose of this study was to undertake a comprehensive review of the New Hampshire State highway program. It includes a detailed summary of the status of New Hampshire highways and their management. The results of a "comparable states" survey is also included as an appendix. It identifies the programs' strengths, some concerns and recommendations on actions to deal with those concerns.

METHODOLOGY

An Advisory Committee was established, consisting of representatives from the State Legislature (Senate and House of Representatives) and the State DOT. The HUF staff spent considerable time in residence at the DOT and collected large volumes of data that describe the highway system, highway finance, highway conditions and performance, highway program needs, and the management and productivity of the DOT.

The data were analyzed, numerous interviews were conducted, previous studies were evaluated, and data were obtained from the HUF files and other states.

FACTORS/CRITERIA USED TO EVALUATE PROGRAMS

The HUF staff collected and reported on dozens of factors used to analyze the highway and bridge programs in the state. (They are not listed here because they are so numerous.) The factors relate to all aspects of the highway program including management, operations, planning, design, maintenance, human resources, and physical facilities.

APPLICATION OF RESULTS TO A STATE

The results of this study provided detailed insights for the managers of the New Hampshire state highway program. A number of detailed recommendations were made on all aspects of the program.

This analysis and recommendations were based upon factual information relevant to the state which was analyzed by a team of experienced highway engineering professionals. The conclusions were also developed in consultation with political leaders in the state.

Although comparisons of some statistics were made with five "peer states" (Vermont, Maine, Massachusetts, Idaho, and Nebraska), no comparative analysis was feasible because they were not appropriate data available for doing so.

POTENTIAL APPLICATIONS TO COMPARE STATE PROGRAMS

One could conclude that this kind of detailed analysis for a particular state, if conducted for a number of "peer" states, would provide an excellent basis for a state-by-state comparative analysis.

COMMENTS

Even if such detailed data were available for a number of peer states, there is still an important concern. It may not be appropriate to simply make comparisons of certain statistics concerning a state highway program. An appropriate analysis methodology must be developed in order to do so in an objective and scientific way.

STATE

New Jersey

TITLE

Nationwide Variations in the Cost of Highway Construction: Implication for Future Surface Transportation Policy

DATE

August 1990

PREPARED BY

New Jersey Transportation Coordinating Council, Committee on Transportation Financing

CONTACT

Thomas M. Downs

PURPOSE

To show that there are significant cost variations in highway and bridge construction costs across the nation. Developed as a resource to make a case to Congress to include these factors in allocating ISTEA funds.

METHODOLOGY

Using FHWA data (which is submitted yearly by each state) the study showed that costs of highway and bridge construction vary by well over 100% among states. This is a very significant fact when comparing state needs and the ability to meet those needs. The report also emphasizes significant (but explained) inconsistencies in the FHWA statistics.

FACTORS/CRITERIA USED

This study analyzed FHWA data on the price of six contract items commonly used in highway construction. They included common excavation, portland cement concrete surfacing, bituminous concrete surfacing, reinforcing steel, structural steel and structural concrete. Data were obtained for the 50 states.

APPLICATION OF RESULTS TO A STATE

This study was undertaken to document the significant cost differences in states and regions.

POTENTIAL APPLICATIONS TO COMPARE STATE PROGRAMS

The costs for highway construction and maintenance can vary by well over 100% from state-to-state. This fact alone makes it clear that simple cost comparisons among states are inappropriate in evaluating state performance.

COMMENTS

This study clearly illustrates that in order to make state-by-state comparisons of highway program, it is necessary to develop evaluation methodologies that incorporate significant costs variations. In addition, not only meet construction costs be considered, but in the case of NJ it was shown that the following must be considered in evaluating FHWA statistics:

- The New Jersey report utilized total funds received, but did not factor in actual disbursements for state administered programs.
- No consideration was given to funds collected for and used on toll facilities nor the revenues collected and used for transit.

STATE

Oklahoma (1)

TITLE

An Evaluation of the Management of the Oklahoma State Highway Program

DATE

1990 (Dec. 3, 1990 Transmittal Letter)

PREPARED BY

Highway Users Federation

CONTACT

P.J. Driskill

PURPOSE

To evaluate the effectiveness of Oklahoma's total highway program in meeting its citizens needs for safety, service and cost-effective transportation now and in the future.

METHODOLOGY

This is a typical HUF evaluation, covering many management, finance, needs, performance and productivity issues.

RELEVANCE TO NCHRP STUDY

As in the case of each of the HUF reports, this contains a chapter on "Productivity" which compares Oklahoma to other states. Each report also identifies the state differences concerning demographic, financial, geographic, etc., characteristics.

See New Hampshire HUF report for more detail.

STATE Oklahoma (2)
TITLE Oklahoma Highway Program Review: Phase B
 Recommended Plans for the Reorganization of the OK DOT and
 Administration of County Roads Program
DATE April 1991
PREPARED BY Highway Users Federation
CONTACT Marshall F. Reed, Jr.

PURPOSE

To make recommendation for reorganizing the OK DOT and for improving the administration of the state funds for county roads and bridges.

METHODOLOGY

This was a separate report prepared for the purpose stated, but as a follow-on to the initial management report dated December 3, 1990 by HUF.

RELEVANCE TO NCHRP STUDY

Statistical comparisons were made to Washington State and Mississippi. But there was no comparative analysis undertaken.

STATE Oregon
TITLE Oregon Highway Program Review
DATE 1988
PREPARED BY Highway Users Federation
CONTACT Mark Ford
 Manager, Policy and Strategic Planning Section, Oregon DOT

PURPOSE

To evaluate the overall effectiveness of the Oregon highway program.

METHODOLOGY

This is a typical HUF report . See New Hampshire HUF report for more detail.

STATE Texas (1)

TITLE High Precision Determination of State HPMS Component Weighting Factors Using the Analytic Hierarchy Process

DATE February 1992

PREPARED BY Ronald F. Haggui, Texas DOT

CONTACT Thomas A. Griebel
Director, Planning and Policy Division, Texas DOT

PURPOSE

To determine if more precise measurements of highway system performance can be established using the Analytic Hierarchy Process (AHP).

METHODOLOGY

The Highway Performance Monitoring System (HPMS) is an analytical computer model used by the FHWA as the basis for assessing highway needs and costs nationwide. Used since the late 1970's, each state collects sample data that define a composite index of nine variables that quantify highway condition performance. The HPMS model is highly sensitive to the component weights of the performance functions, so some states have begun modifying "national average" default values in the model in order to represent their own specific highway condition priorities. The subject report stated that: "Failure to correctly quantify these priorities would cause the model to optimize the wrong factors, producing an inappropriate highway strategy for that state." The purpose of the research described in this report was to examine the extent of uncertainty about what the index weights should be in the HPMS model, and how "Analytic Hierarchy Process" (AHP) can improve the confidence in these determinations. The research concluded that all significant measurements of highway performance are not equally important, and that relevant weighting factors are needed. The report demonstrated how subjective weightings can be made with increased confidence using a feature of the Analytic Hierarchy Process.

RELEVANCE TO NCHRP STUDY

This is a very relevant analysis of the HPMS process that appears to clearly demonstrate that all measures of performance are not equally important. The key conclusion is that weighting factors are needed.

STATE Texas (2)

TITLE Improving R&D Project Selection with Analytic Hierarchy Process

DATE November 1990

PREPARED BY Ron Haggui, Texas DOT

CONTACT Thomas A. Griebel
Director, Planning and Policy Division, Texas DOT

PURPOSE

To determine if the application of the Analytic Hierarchy Process (AHP) can provide greater precision in prioritizing highway research projects.

METHODOLOGY

This document provides a large series of slides (transparencies) which summarize a procedure used by the Texas DOT, Division of Planning and Policy, to test the application of AHP in selecting priorities from among competing highway research projects. The results indicated that the AHP does provide a more analytical approach in providing a framework to meld the scores and weighting of various priorities to provide a better overall measure of potential research payoff.

RELEVANCE TO NCHRP STUDY

The presentation demonstrates that a complex set of variables can be analyzed with a greater degree of confidence when using AHP for measuring the potential "performance" of competing research projects. Thus, AHP could also be relevant for measuring highway performance characteristics as well.

STATE Texas (3)
TITLE SDHPT Performance Measurement Project: Assessing Effectiveness and Efficiency
DATE June 1991
PREPARED BY Ronald F. Haggquist, Texas DOT
CONTACT Thomas A. Griebel
 Director, Planning and Policy Division, Texas DOT

PURPOSE

To present a basic framework for evaluating extensive lists of performance effectiveness measures.

METHODOLOGY

There are potentially a large number of planning, performance measurement and efficiency analysis methods that provide feedback measurements between "resource allocation and results." Extensive lists of performance effectiveness measures are relatively easy to compile. But, the availability of numerous efficiency measures are difficult to interpret as a group. This brief paper suggests that an efficiency assessment system such as "Data Envelope Analysis" should be used to more accurately determine which ranking factors are most important in analyzing results of actions.

RELEVANCE TO NCHRP STUDY

This could provide a useful analytical framework for evaluating highway program performance.

STATE Texas (4)
TITLE Assessing DOT Operational Efficiency with Data Envelope Analysis
DATE May 1991
PREPARED BY Ronald F. Haggquist, Texas DOT
CONTACT Thomas A. Griebel
 Director, Planning and Policy Division, Texas DOT

PURPOSE

To discuss the potential value of Data Envelope Analysis (DEA) in assessing the efficiency of the operational units of the Texas DOT.

METHODOLOGY

DEA is a rigorous mathematical method developed over the last decade by Charnes and Cooper to analyze and compare operating efficiencies. Texas DOT examined the potential application of DEA to make comparisons between SHD District Offices for all functions (maintenance, construction, etc.). If successful, it could be used to evaluate the performance of all activities for each District.

RELEVANCE TO NCHRP STUDY

The Texas study concluded that comparison of "efficiencies" to average values do not give useful information about how to attain peak efficiencies. This is especially true when there are multiple inputs, multiple outputs and multiple complicating factors to take into account. The study shows how the DEA approach can provide supportable overall performance measures when multiple complicating circumstances must be correlated, while avoiding subjective weightings with some type of optimization technique.

STATE Texas (5)
TITLE A Pilot DEA Analysis of Maintenance Section Relative Efficiencies
DATE January 1992
PREPARED BY Ronald F. Haggui, Texas DOT
CONTACT Thomas A. Griebel
 Director, Planning and Policy Division, Texas DOT

PURPOSE

To apply DEA analysis in comparing the effectiveness of Texas DOT maintenance programs.

METHODOLOGY

This report provides the data results, with no explanation.

RELEVANCE TO NCHRP STUDY

The comparisons among state systems could be viewed as analogous to comparisons among maintenance sections within a state (Texas is this case.)

STATE Texas (6)
TITLE Comparing State Transportation Systems and Agencies Through the Construction and Analysis of Regional and State Level Data Base
DATE November 1991
PREPARED BY W. Luker, Jr., and Dock Burke
 Texas A&M, TTI
CONTACT Dock Burke

PURPOSE

To compare the functions and characteristics of transportation programs in the WASHTO states.

METHODOLOGY

This report describes the results of a study to construct and analyze a regional data base composed of information about the individual states and the state DOT's who are members of WASHTO. It clearly documents the similarities, but many differences among those states due to climate, geography, economics, etc.

RELEVANCE TO NCHRP STUDY

This study shows that there are such significant differences among the states, that it would appear to be unwise to compare states on simplistic grounds.

STATE Utah
TITLE Revenue Available to Transportation Programs
DATE June 15, 1992
PREPARED BY UTAH DOT
CONTACT Van A. Sutherland

PURPOSE

To show taxing sources that are used primarily for highway purposes in Utah.

METHODOLOGY

UTAH DOT conducted this study in 1991 to show transportation funding sources available in other states. It resulted in a table of "cents per gallon equivalent tax revenue" for each state. This resulted in a range of 78.6¢ for New York to 22.6¢ for South Carolina.

RELEVANCE TO NCHRP STUDY

There is such a broad diversity in tax sources that this provides, no relevant information other than the need to consider "diversity". However, it is interesting to note that small rural states such as Kansas, New Hampshire and Nebraska have "equivalent" values that are in the same relative range as for very large urban states such as Minnesota, Wisconsin, Maryland, New Jersey, etc.

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