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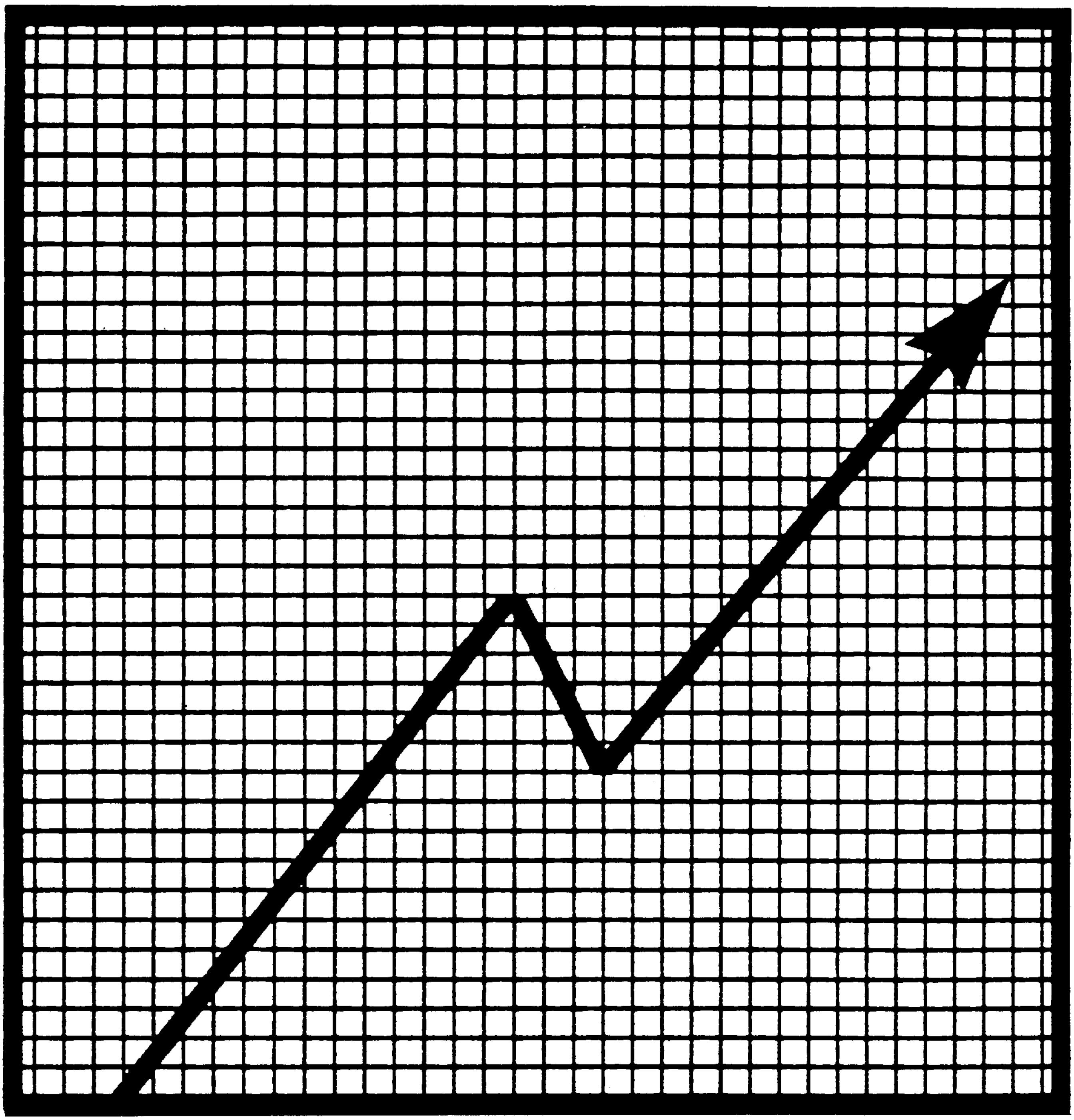
The Use of Intermodal Performance Measures by State Departments of Transportation

June 1996



The Use of Intermodal Performance Measures by State Departments of Transportation

Final Report
June 1996

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ABSTRACT

This report identifies specific intermodal performance measures developed by 15 State departments of transportation. The performance measures are classified by goals and analyzed by frequency of use. The report discusses the role of performance measures in the transportation planning process and their relationship to intermodal management systems. The report also summarizes the major research reports related to the topic of performance measures.

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THE USE OF INTERMODAL PERFORMANCE MEASURES BY STATE DEPARTMENTS OF TRANSPORTATION

CHAPTER 1 OVERVIEW

Introduction

The performance levels of existing transportation systems need to be evaluated objectively, in order to accurately monitor system efficiency and to specify improvement strategies. Performance measures are the means by which such evaluations are made. Performance measures are indicators of system performance compared to a definition of what is acceptable - a performance standard.

Performance measures are a critical element of intermodal planning. They influence the types of data that should be collected and the types of analytical tools that can be used. They also define the type of information that will be provided to decision makers. Possible performance measures include: access limitations to intermodal facilities, coordination among modes, regulatory constraints, delivery and collection systems, safety, and economic/environmental tradeoffs.

The ability to improve a transportation system's effectiveness depends to a great extent on the ability to measure a given level of performance. Acting as a counter balance, a performance measurement can readily identify internal problems, separating them from external factors beyond the control of transportation management. In other words, rather than "passing the buck," transportation planners can recognize where they can act to correct problems or improve system elements.

ISTEA and the Need to Define Performance Measures

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) required that all States implement a performance-based planning process aided by an Intermodal Management System (IMS), to improve the effectiveness of Statewide and metropolitan transportation systems.

ISTEA mandated that, as of October 1994, all States would have work plans, inventories of intermodal facilities, and begin IMS data collection. By October 1, 1995, the States were mandated to establish performance measures, have system design underway (preferably completed), and have full-scale data collection underway (also preferably completed). The States were also granted an additional year to have their respective IMS fully operational.

Subsequent to these requirements, Congress passed the National Highway System Designation Act of 1995. Section 205 of this act amended Section 303 of ISTEA. It now states, "A State may elect, at any time, not to implement, in whole or in part, one or more of the management systems required under this section. The Secretary may not impose any sanction on, or withhold any benefit from, a State on the basis of such an election." In effect the revised section makes all management systems optional.

However, many states recognize the value of the management systems and are continuing with the development and implementation of such systems. Performance measures are a critical element in creating effective management system

Performance Measure Report

Agencies have approached the development of performance measures in many ways. As a result of the myriad approaches, it has been difficult for one individual to gain a perspective of the range of measures and how they are being applied by different State departments of transportation.

This report clarifies the role of performance measures in the planning process. It also identifies how performance measure development is being approached by State DOTs. The report is directed at individuals who are responsible for the development and monitoring of performance measures at State DOTs and metropolitan planning organizations.

The substantive portion of the report is presented in Chapters 2 through five. The second chapter discusses the role of performance measures in the context of a revised planning process which has resulted from changes brought about by ISTEA.

The third chapter provides a review of research related to transportation performance measures. The research has been prepared during the past two years by different agencies and independent researchers. The section explains how performance measures can evolve from a relatively simple list of existing indicators to a sophisticated set of integrated measures. In this form they can provide a clear picture of the effect of an intermodal transportation system on its users.

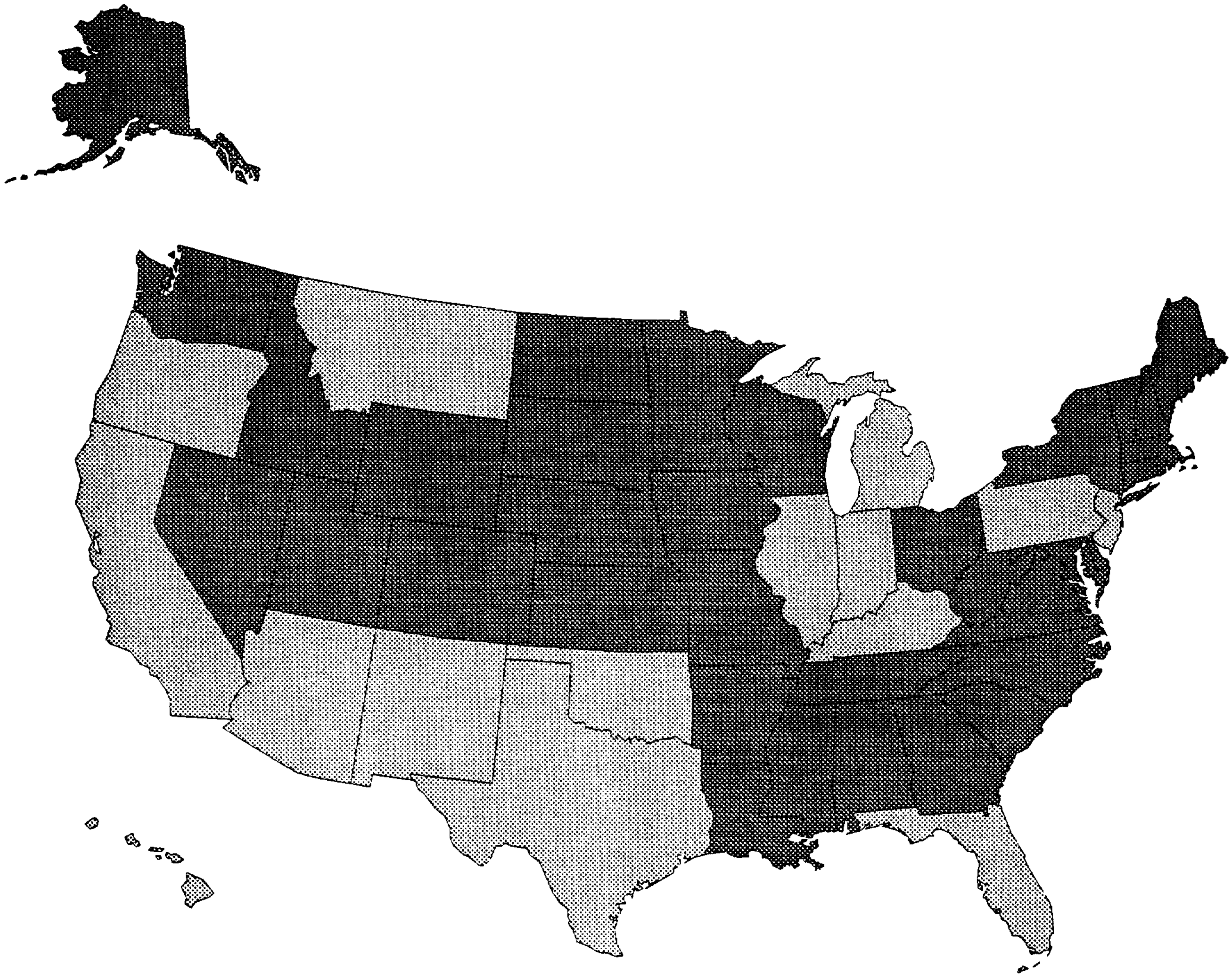
The fourth chapter identifies freight performance measures developed by States for their intermodal management systems. The measures are categorized by their relationship to a set of goals.

The fifth chapter lists individual intermodal performance measures for passenger movement. It also identifies the States that have used the measures.

The performance measures in chapters four and five are categorized by synthesized goals Statements that were derived from the goal Statements of State work plans.

The performance measures are based on a review of 15 intermodal management system work plans from State DOTs. The States include: Arizona, California, Florida, Hawaii, Indiana, Kentucky, Michigan, Missouri, Montana, New Jersey, New Mexico, Oklahoma, Oregon, Pennsylvania, and Texas (Figure 1.1). The intermodal performance measures from the States are presented with their related goals in: Appendix A - Freight Performance Measures and Appendix B - Passenger Performance Measures

Figure 1.1 Intermodal Performance Measures: States Surveyed



Scale one inch represents 450 miles

Surveyed States

Montana was not surveyed for passenger performance measures

CHAPTER 2
PERFORMANCE MEASURES AND THE PLANNING PROCESS

Introduction

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) adjusts the way public transportation planning agencies undertake transportation planning. For many agencies the adaptation and the National Highway System Act of 1995 recommend changes in their organizational structures and/or in the methods employed to plan for transportation facilities or program development.

One of the major tasks in the adjusted planning process for the State departments of transportation (DOTs) and metropolitan planning organizations (MPOs) is the creation of management systems. A focus of management system development is the establishment of performance measures. For example, when agencies develop their Intermodal Management Systems (IMS), the Interim Final Regulations State,

> Parameters shall be identified that are suitable to measure and evaluate the efficiency of intermodal facilities and systems in moving people and goods from origin to destination...Since the expectations and measurements of transportation quality of service vary between communities and industries, performance measures shall be established cooperatively at the State and local levels with private sector coordination, as appropriate.

Background—The Planning Process and Performance Measures

The creation of the ISTEA instituted a series of changes in the methods of transportation planning and programming. Initially, there was some confusion between States and MPOs about the effect of the ISTEA on the planning process.

Before the ISTEA, the transportation planning process as used by the Federal Highway Administration (FHWA) had changed little since it was originally implemented in the 1960s. The single exception was that planning horizons tended to be shorter (Weiner). The process of setting goals, establishing objectives, studying alternatives and making a project selection is part of a well-documented method for planners (Figure 2.1).

The passage of the ISTEA provided the States the opportunity to create a performance-based planning process. Although this only slightly changed the order of the steps in the planning process, it held significant implications for the effectiveness of transportation programs and policies in the future (Figure 2.2).

The adjusted planning process places a new emphasis on evaluation—determining the effectiveness of transportation planning and programming efforts. This is important if we consider that competition for resources.

Figure 2.1 Traditional Planning Process

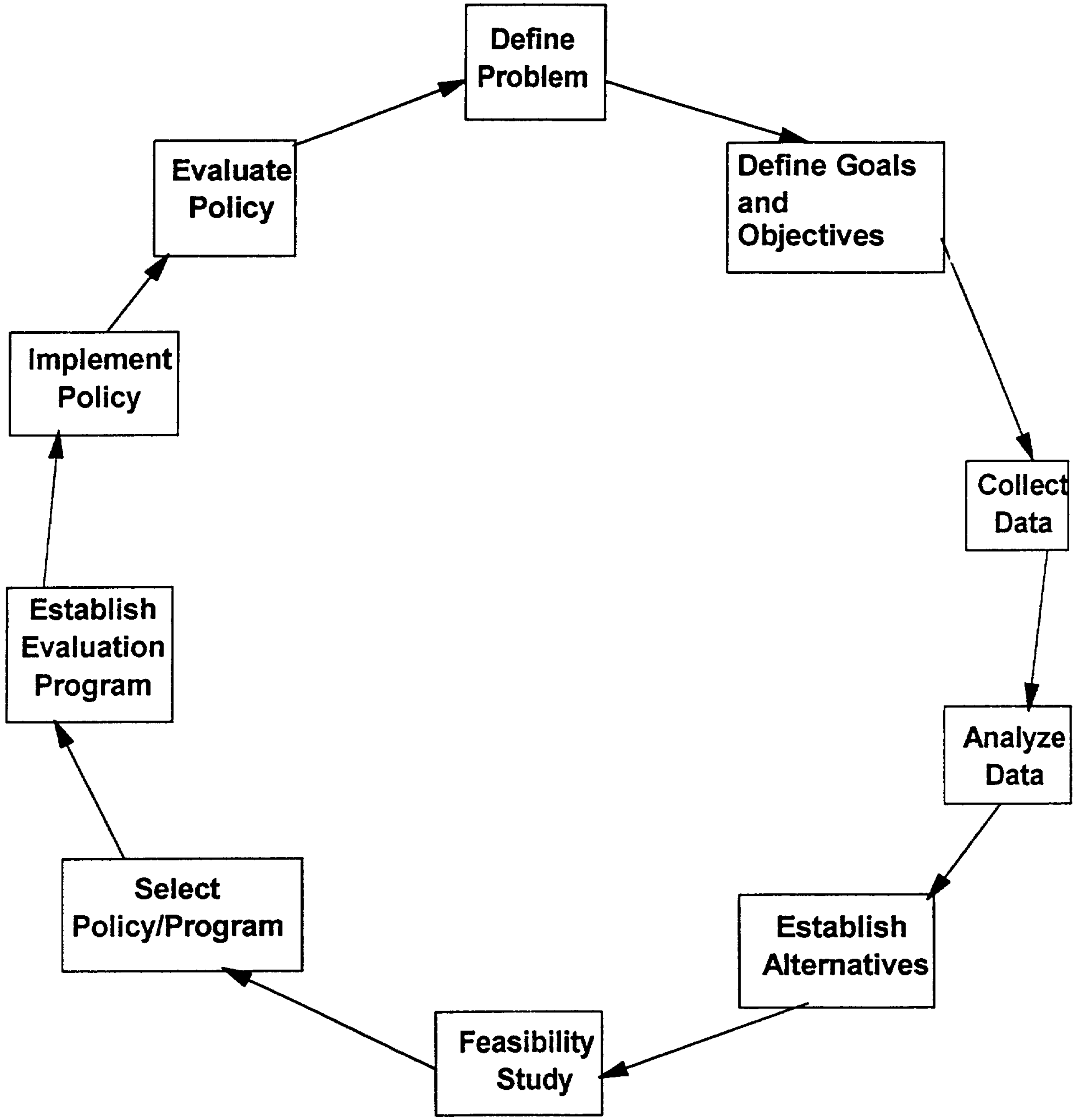
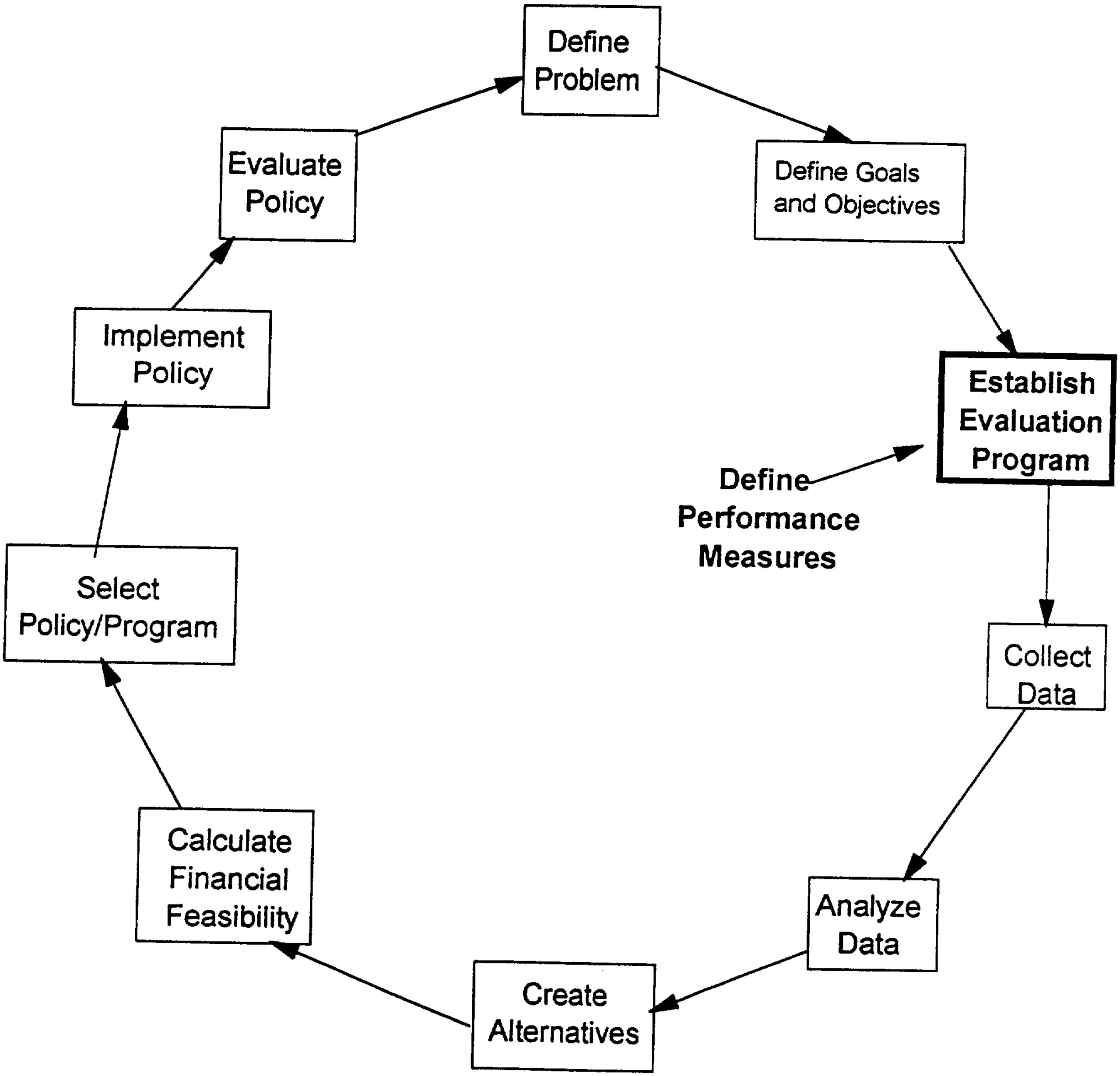


Figure 2.2 Performance Based Planning Process



will increase in the future. The policies and programs which are most effective e.g., rate highest using performance measures will receive the lion's share of funding.

If the traditional planning process is compared to the adjusted process, one notices the addition of performance measures after the creation of goals and objectives. Until this change was made, evaluation indicators were often pushed to the end of the process. They represented a minor step in the planning process. From this perspective the evaluation program is an afterthought. It is not done until after a program or project has been selected and only if the program or project has been implemented.

By placing performance measures into the planning process immediately after the creation of goals and objectives, they assume added importance (Moore). Performance measures influence the overall process as do goals and objectives.

Performance measures do not replace goals and objectives. In fact, performance measures should be derived from them. Nevertheless, the strategic location of performance measures makes evaluation an integral element of the planning process. Furthermore, the placement of the performance measures at this point also helps to explain the integral role of a management system in the planning process.

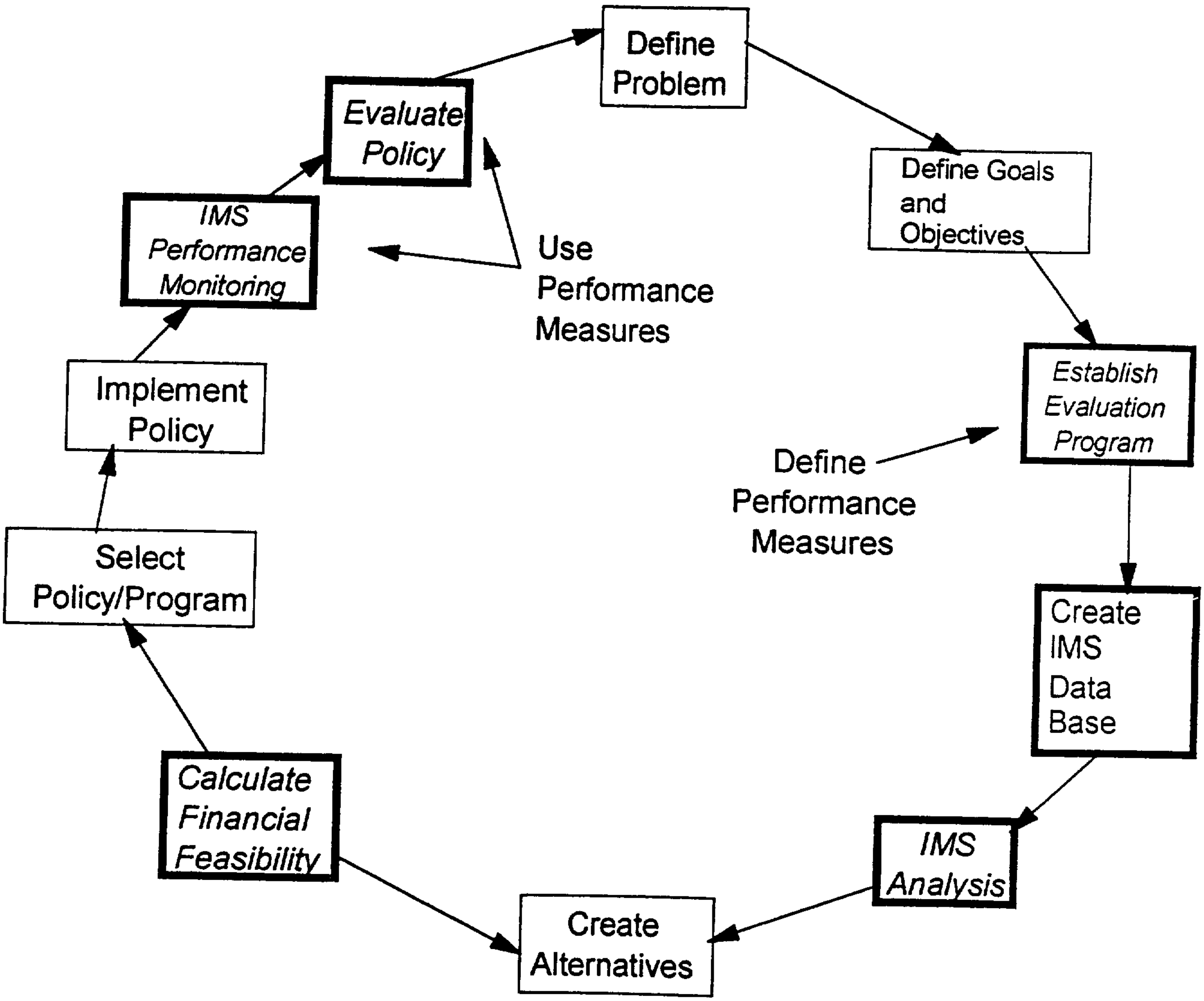
A management system can be used to select projects and set policy. It can also be used to measure the effectiveness of those actions in terms of goals and objectives (Figure 2.3). This relationship suggests that data collection and analysis are accomplished in the context of two factors, established goals and objectives and a set of performance measures. The need for data is reduced because only those data which provide information about performance measures and objectives should be collected. If the two factors are not used to determine what data should be used, data collection can become an overwhelming and expensive procedure.

Conclusions

The steps in the planning process have not been changed in a consequential way. The placement of performance measures at an early stage in the process gives evaluation added importance.

The significance of the revised process is that in the immediate future, transportation planners will have the opportunity to develop elementary measures of the effectiveness of their plans and programs. In the long run the opportunity exists to determine how well the system provides accessibility and mobility to the users of a transportation system

Figure 2.3
Role of the Intermodal Management System in the Planning Process



CHAPTER 3
REVIEW OF PREVIOUS RESEARCH ON PERFORMANCE MEASURES

Introduction

Prior to 1993, there was a lack of substantive material on performance measures related to transportation. The passage of the ISTEA gave impetus to the creation of a number of reports by transportation researchers and professional staff at State DOTs and MPOs. At present, a significant body of information has been created that provide insight into performance measure use. Transportation planning practitioners are faced with the problem of filtering through a large amount of disparate material. The following section represents a synthesis of the most prominent research undertaken to date on performance measures.

Previous Research Defining Performance Measures

The order in which the following research summaries are discussed is not chronological (in fact, much of the material is undated). This chapter begins with earlier research that focuses on promoting the utilization of available resources to define performance measures and hence to initiate a simple Intermodal Management System (IMS). The research summaries then explore the specifics of identifying intermodal transportation issues and goals before defining performance measures. The latter research details the role of performance measures in an evolved, mature IMS.

The chapter closes with a summary which illustrates that the primary focus of future research concerning performance measures should be on mobility.

Dane Ismart
Intermodal Management Systems: Technical Guidelines Undated

Dane Ismart's memorandum provides a technical guideline for successfully implementing an IMS. According to Ismart, the key is simplification. Because of limited State planning resources, the nonexistence of detailed intermodal data, and the lack of technical planning procedures for evaluating traffic between modes, starting with a data-intensive, sophisticated IMS will only guarantee failure.

To overcome the lack of data, intermodal transportation planning agencies must use existing resources to develop an IMS that is issues oriented. A typical list of issues might include:

- Physical limitations to intermodal movement.
- Accessibility of intermodal facilities.
- Transferability and coordination between modes.
- Legal and regulatory constraints to intermodal transportation.
- Delivery and collection systems for intermodal facilities.
- Safety of intermodal facilities and systems.
- Economic and environmental tradeoffs between modes.

Each of these issues should be addressed by establishing performance measures and standards to evaluate the effective operation of intermodal transportation systems. Such performance measures and standards would not only be used to evaluate the current operation of intermodal facilities, but would be the baseline for determining how various transportation strategies and investments would impact the movement of people and goods as part of an overall transportation system.

In order to efficiently implement an IMS, performance measures should be based upon available data or data that is easily accessed by the intermodal transportation planning agency. There are literally hundreds of performance measures that could be used as part of an IMS. The key is to establish a basic structure of performance measures that could be implemented with a reasonable amount of effort, despite constraints and resource limitations, and in accordance with State transportation needs. Ismart's message is to, "Keep it simple."

Identification of intermodal transportation issues will be the key to implementing an IMS. After the issues have been identified, an appropriate set of performance measures and standards can be developed to provide the framework for an IMS.

State of Oregon

The State of Oregon undertook a pragmatic approach to performance measures' selection. The Dye Group, consultants for the Oregon Department of Transportation, examined potential performance measures

and standards and related them to the existence of supportive data.

According to the report, an intermodal transportation system needs to consider traffic generation characteristics, the corridors along which movement occurs, the locations of terminals (transfers from one mode to another), and the links between intermodal terminals and corridors. The State intermodal transportation system consists of such elements for the movement of both goods and people.

The State of Oregon defines performance measures as instruments that grade the accessibility of each employment center/activity center (traffic generators) by measuring the percentage or number of employees/residents/consumers within a specific distance.

These are not some measures of congestion. Rather, Oregon's focus has been on vehicle miles traveled (VMT). Chiefly concerned with improving overall air quality, Oregon measures the potential for VMT savings afforded by reducing travel distances, and vice versa.

This approach is user-oriented and simple for the layman to understand. It reflects the benefit of having trip origins and destinations within close proximity to one another. It measures the potential for VMT reduction as an indirect benefit of planning for balanced land uses. However, it is not a measure of, nor does it address, congestion.

State of California

Caltrans has been a leader in the development of performance measures. According to Booz, Allen and Hamilton, Inc., consultants to Caltrans, performance measures are to be used by the State for consideration in selecting projects and for monitoring system performance. California is opposed to collecting data before defining issues to which the data will be applied. Performance measures were adopted after system issues and goals were defined.* A list of desired data was developed only after performance measures were established.

State of Florida

Florida's research also identifies performance measures as a means of project selection (Meyer). Performance monitoring, and thus performance measures, provides a level of assurance that the most effective projects are selected. The emphases of the Florida system are on the continued monitoring of current projects and to foster proper selection procedures for future projects.

Performance measures are crucial to evaluating intermodal system components, how intermodal components are incorporated into the overall transportation system, and what they will entail. Therefore, performance measures are used to determine how investments will be made in the transportation system.

*Booz, Allen Hamilton, Inc. indicted that a key ingredient to the success of the development of performance measures was the role of the State steering committee and the level of consensus building between State and local transportation agencies.

State of Ohio

"Access Ohio" is Ohio's planning response to the intermodal transportation planning mandates issued under ISTEA. It represents a new approach to monitoring intermodal systems in that State. Each adopted performance standard is measured by the degree to which it meets a category or issue of concern to the State. For example, economic development is one of Ohio's primary concerns.

The Access Ohio Mission Statement calls for the people of Ohio to be served by the planning, building, and maintenance of a safe, efficient, and accessible transportation system that integrate all modes of transporting people and goods to foster economic growth and personal travel. Hence, economic development goals can become intermodal transportation system goals. Transportation performance measures, then, can serve as indirect indicators of present and future economic health of the State.

Intermodal transportation planning relates system improvements to their level of contribution to optimizing investment and performance of the system. Transportation investment can be linked to an analysis of economic competitiveness that indicates which investments would provide the best economic benefit.

John P. Poorman, Capital District Transportation Committee
The Metropolitan Congestion Management System and Freight Issues
December 1993

The Capital District Transportation Committee (CDTC) is the MPO for the metropolitan area surrounding Albany, Schenectady, and Troy, NY. CDTC is working with the State of New York Department of Transportation (NYSDOT) to determine the appropriate form and content for the management systems mandated under ISTEA. This has been the focus of CDTC's research.

The CDTC study points to the need for analytic procedures to develop standards for the performance of an intermodal transportation system. According to Poorman, performance measures should concentrate on the concept of "excess delay." Poorman assumes that all travel, experiences some amount of delay relative to free flow conditions. Excess delay is defined by Poorman as, "The amount of time spent at a given location that exceeds the maximum amount of time that is generally considered acceptable for transporting people and goods."

Standards of acceptable delay are primarily focused on auto travel. Comparable parameters are not available, and need to be defined, for other modes of transport. For example, the Highway Capacity Manual details Level of Service (LOS) standards and traffic density thresholds for roadways. Other modes of transport need identified standards that can be translated into similar terms. For example, the number of pedestrians per hour per foot-width of sidewalk, where at a certain threshold level a pedestrian walkway is made separate and distinct from a roadway.

It would be difficult to identify appropriate performance measures without stating the purpose for an evaluation strategy. Hence, goals are some prerequisites of performance measures. Goals should be adopted via an objective dialogue among various transportation interests.

Poorman indicates that choices cannot be made in a vacuum. He states that, "Each transportation investment or policy contributes to creating an environment that either positively or negatively impacts the economic health, natural environment, and quality of life for area residents." However, a broad vision for the overall transportation system can positively shape individual decisions. An objective dialogue should be included as part of the intermodal transportation planning process, to resolve conflicts and clarify differences over competing visions for the future. Freight shippers and carriers must contribute to the articulation of a vision that includes consideration of the economic contribution of commercial freight traffic.

Transporters of freight have a large stake in regard to the development of the State and MPO intermodal management systems. Freight transporters must participate in the intermodal transportation planning process, in order to assist the States and MPOs to identify the proper performance measures that indicate the efficiency of the intermodal transportation system from the viewpoint of the freight user.

Without such participation, transportation planning will continue to focus on personal travel (i.e., single-occupant passenger cars). Poorman warns that continuing this focus could work to the detriment of the freight user and to modes of transport other than the personal automobile.

Cambridge Systematics, Inc. with Barton-Aschman Associates, Inc.
<u>Analytical Procedures to Support a Congestion Management System</u>
March 1994

Cambridge Systematics, Inc. and Barton-Aschman Associates, Inc.'s research provides technical guidelines to successfully implementing a congestion management system (CMS). However, their research is also relevant to the development of IMS performance measures. They illustrate that the perceptions of how a transportation system is operating maybe just as importantly as operational data collected. Qualitative, consumer perceptions can be very helpful in identifying both transportation problems and potential solutions. Performance measures can be used to provide a systematic compilation and analysis of consumer comments or suggestions. Performance measures can also be used to display the temporal and spatial extent of these transportation perceptions.

Barton-Aschman Associates, Inc.
<u>Intermodal Management System for the Metropolitan Phoenix Area</u>
Undated

Barton-Aschman Associates, Inc. researched the problems and opportunities of providing an IMS for Metropolitan Phoenix. According to Barton-Aschman, performance measures are the basis that determines the efficiency of a transportation system or an element of the system. Performance measures are particularly useful in making comparisons with another system, or comparisons of the same system over time.

Performance evaluation requires the specification of desired goals for the transportation system. To convert these goals to performance measures, they need to be expressed in standardized units (i.e., average speed per, average delays per, etc.). The measurement of a system's performance in relation to the attainment of specific goals is necessary to compare alternative transportation improvement options or policies. Units of measurement must be defined and a procedure for estimating system performance must be devised, in order to accomplish such an evaluation. The measurement of performance needs to be as quantifiable as possible.

Barton-Aschman provides general goals as the framework for intermodal management systems. They include:

- Choices-Increase the opportunities available to have transportation users select from more than one mode. Define actions that can be implemented by public agencies or private companies to support the provision of a variety of modes.

- Connections-Provide convenient, rapid, and efficient transfers between modes. Provide safe transfers between modes.

- Coordination-Involve representatives of both the public and private sectors in the planning process. Develop actions that will be implemented by both the public and private sectors in support of the overall intermodal goal.

Performance measures should relate directly to measuring the attainment of goals affecting the choices, connections, and coordination among modes (listed above). They should also rely on the use of existing or available data.

Bahar B. Norris
<u>Intermodal Performance Standards: A Primer for Transportation Planning Practitioners</u>, Volpe National Transportation Systems Center
July 1994

Bahar Norris has identified performance measures and performance standards as a crucial ingredient of the IMS. Norris outlines a series of steps for IMS development. Although the presentation is unorthodox relative to the traditional view of IMS planning, it provides some interesting insights into the relationships between performance measures and the other components of the planning process. Prior to identifying performance measures or standards, a set of system objectives must be identified. This step involves outlining the system goals and objectives and setting quantitative or qualitative targets. The performance standards receive impetus from the system objectives. They become the basis for a decision support system from which to select investment alternatives. System objectives will differ based upon unique regional needs, values, perceptions, etc. Examples of some system objectives are:

- Improve service levels.
- Improve facility access and system connectivity.
- Reduce transfer time among modes.
- Reduce emission and energy consumption.
- Reduce travel time and congestion.
- Improve quality of life and regional output.
- Enhance safety.

- Augment the effectiveness of the ongoing Intelligent Vehicle Highway Systems (IVHS) system improvements by incorporating them into performance standards.

Identifying performance standards is a multi-tiered task. Target markets must be identified, for example system users versus system operations or nonuser effects such as energy conservation, ambient air quality, or economic growth. A consensus must be established on the measures to be used for gauging the performance of the system operations. Trigger mechanisms, actions to be taken automatically when predetermined performance levels are reached, must be established to enforce the standards. Then performance standards can be developed based on established performance measures.

Norris suggests that the process of building a consensus about performance measures to be implemented should be firmly grounded in a knowledge of the unique regional attributes of a region.

In designing intermodal performance standards themselves, the primary emphasis should be on modal interconnectivity as the pivotal criterion for the IMS. Overall system mobility should be considered as a secondary emphasis. The complexity of IMS objectives requires that performance standards be established for three levels of intermodal activity: network infrastructure, modal operations, and terminals and transfer facilities.

Finally, it is necessary to devise strategies to link system goals to performance standards. This step involves establishing logical and operational links between performance standards and the possible range of strategies that could be pursued to achieve the objectives promoted by the standards.

Louisiana Transportation Research Center (LTRC)
<u>Defining Performance Measures for an Intermodal Management System</u>
April 1994

The Louisiana Transportation Research Center (LTRC) examined the nature of performance measures and defined those parts of the transportation systems to which they should apply. According to LTRC there is confusion between the concepts of performance measures and performance standards. Performance standards should answer the question, "What is desirable and how important is it?."

Performance standards represent the levels of performance that are considered to represent specific levels of acceptability. A good example of this would be the scale of roadway levels of service outlined in the Transportation Research Board's Highway Capacity Manual. Performance standards act as a "critical value" for performance measures, and flow directly from the definition of performance measures. Performance standards represent certain levels of performance, or efficiency, that serve to distinguish between significant ranges of performance (superior, good, satisfactory, poor, inferior, etc.). The measures and standards, then, help to define the types of decisions that may be needed to change performance to more acceptable levels. The evaluation of transportation systems can be done effectively only by the application of appropriate performance measures.

LTRC has stated, as a conclusion of their study, that neither performance measures nor performance standards for intermodal systems would differ much from one geographic area to another. Louisiana has therefore focused the efforts of this research on development of a framework for defining comprehensive national intermodal performance measures, and to define the nature of performance standards.

Performance measures and performance standards will be the main ingredients of the evaluation process for alternatives generated by the intermodal planning process. There are likely to be several variables that will affect the setting of performance standards, such as cargo "sensitivity" (time, temperature, toxicity, etc.), but would not affect the different performance measures. LTRC defines performance measures as a strict measure of the efficiency of the transfer activity that takes place through a terminal.

It should be noted that this definition limits performance measures to the transference of people and goods from one mode to another, rather than pertaining to the "total trip" which would include connecting links of the same mode.

Richard H. Pratt and Timothy J. Lomax
Performance Measures for Multimodal Transportation Systems
January 1994

Arguably, the traditional highway capacity-oriented performance measures of the past four decades have worked well for their designed tasks.

However, the ISTEA has ushered in an era of intermodal transportation planning in which the ways performance measures are used have been broadened. Therefore, Richard Pratt and Timothy Lomax have developed a list of requisite performance measurement techniques for intermodal transportation systems:

- Performance measures must be consistent with established goals and objectives.
- They must quantify the effects of an anticipated range of improvement options in order to understand the full range of any impact.
- They must identify effects on the movement of people and goods, and on achievement of travel and shipping objectives (performance measures that are consistent with established goals and objectives).
- Common "denominators" must be established to facilitate comparisons of performance measures between different modes of transportation.
- Performance measures should direct data collection rather than vice versa.
- Multimodal and mode-specific measures should identify individual deficiencies, if any.

- Transportation planners must be knowledgeable and tolerant of the disparate orientations of intermodal transportation system users (public versus private, personal travel versus commercial freight, etc.).

This list provides a basic guide for performance measures that is consistent with the most important aspects of planning and operating an intermodal transportation system.

It is essential that performance measures are consistent with the goals and objectives of the planning process in which they are being employed. Performance measures are key to controlling the evaluation process. Performance measures are used for problem identification. Pratt and Lomax argue that a poor selection of measures has a high probability of leading to undesirable outcomes. This is because ineffective performance measures would impede the evaluation process, and diminish the efficiency of overall system planning. In contrast, performance measures developed in conjunction with established goals and objectives provide the mechanism toward achieving desired ends and ensure that such ends are achieved most efficiently by the solutions offered.

A second crucial step in the design and selection of appropriate performance measures is a clear understanding of their role as an intermodal transportation planning evaluation tool. Therefore, an examination of the entire context in which measures are used is required for selection of an appropriate set of performance measures.

Although not in any particular order, the following list offers the primary uses of performance measures:

- Monitoring and Needs Studies - to identify the location, scale, and nature of transportation problems and/or undertake a transportation needs assessment within a specific study area/planning jurisdiction. Provides a basis for action or investment to correct problems, and sets improvement priorities.

- Design and Operations Analyses - performed during system design and operation plan preparation. Measures identify and assess solutions to specific problems. The assessment process starts with a base case for comparison, often existing conditions, then tests the efficiency of alternative actions to provide a basis for action.

- Evaluation of Alternatives - extensive examination of alternatives, often for Environmental Assessments or Environmental Impact Statements. Performance measures used to establish a base case for comparison, to rank the alternatives, and to select the best investment option. Results may establish funding priorities among projects.

- Policy Studies - use performance measures to describe base case conditions, establish a basis for action, and set priorities. For instance, policy options might include alternative approaches to land use planning and site design, with performance measures used as indirect measures of growth management.

- Development Impact Evaluations - use transportation performance measures to identify the impacts of development proposals and to establish the basis for action/investment. A difficult issue in the deployment of performance measures in development impact evaluations is balancing between local impacts and regional concerns.

- Route Choice - use for routing and scheduling of commercial transport, utility vehicles, and real-time travel choices of commuters and other personal travelers. Congestion or accessibility measures can be integrated into transportation models and algorithms.

The development of a system of transportation performance measures should only be initiated after an examination of the uses and users, a full consideration of program goals and objectives, and the nature of likely solutions. The context in which the measures are to be used should identify an appropriate set of performance measures.

David W. Jones
Intermodal Performance Measures for the Bay Area Transportation System
January 1995

The research of David Jones has provided the guidelines for developing a set of intermodal performance measures for the San Francisco Bay Area. This report indicates that Bay Area congestion has increased significantly, but without producing a corresponding reduction in individual mobility. As the discussion indicates, mobility can be sustained in the face of increasing congestion if a region's travel patterns are access-efficient.

This implies that level of congestion is not necessarily an appropriate measure of mobility (at least not for the Bay Area's intermodal transportation system). Further, this implies that accessibility and sustained movement are more important to transporting people and goods than level of congestion. These are important conclusions, in that they could not be reached using performance measures specific to an individual mode. It is important to note that most transportation performance measures in use today are mode specific.

In the context of the following mobility goals, Jones promotes performance measures that recognize the contribution made by accessibility and logistical efficiency to metropolitan mobility. These include:

- Access to jobs and services,
- Access to the urban core,
- Commute and non-commute access to regional activity centers,
- Efficient goods movement,
- Reliable service,
- Resource-efficient transportation, and
- Safe travel.

Jones stresses the use of performance measures for evaluating an intermodal transportation system's ability to sustain accessibility and mobility.

Commonalties of Performance Measure Definitions

There are some identifiable commonalties within this disparate research material. Common to most performance measure applications is the establishment of base case conditions, identification of problems, and assessment of options for problem resolution.

The most notable common denominator is the recurring theme of identifying system goals prior to defining performance measures. Dane Ismart and Bahar Norris both stress the identification of system issues, goals, and objectives before developing performance measures and standards. Richard Pratt and Timothy Lomax, as well as Barton-Aschman, John Poorman, and the State of California also emphasize this point.

Dane Ismart and the State of Oregon emphasize one overriding theme - KEEP IT SIMPLE! Resources and personnel are limited. To develop an elementary yet effective IMS, performance measures must be kept simple and based upon available data.

As the IMS matures, new data sources can be created and the performance measures can evolve in complexity to correspond with the nature of the intermodal transportation systems that they represent.

Project selection is an important use of performance measures. The States of Florida and Ohio both utilize performance measures to determine the allocation of transportation funding. Primary funding goes to projects that directly or indirectly further a State intermodal transportation planning goal (economic development, air quality, land use/population density, etc.). For example, Ohio uses performance measures to further economic development through transportation improvements. Florida, on the other hand, may use its performance measures to attain higher air quality through transportation improvements.

Except for the Louisiana Transportation Research Center (LTRC), most of the research views performance measures as an evaluation of the total trip of a person or good - links, nodes, transfer among modes, etc. Conversely, in the context of the IMS, the LTRC views performance measures solely as an evaluation of intermodal transfer points - the efficiency of the transfer of a person or good between modes of transport.

The research by LTRC, Pratt and Lomax, Poorman (CDTC), and David Jones all emphasizes the inclusion of freight users in the decision making processes. They are concerned that the focus of transportation planning will remain on personal travel via private automobiles which have the potential to impede the implementation of Statewide and intermodal transportation planning. As evaluations may be done by different groups for different reasons, an evaluation procedure needs to take into account different perspectives and bring them into an objective, comprehensive framework.

One prominent theme in all research, is the absolute necessity of including appropriate performance measures in the intermodal transportation planning process. Simply put, one cannot know if something "good" or "bad" is occurring unless it is measured. David Jones and Pratt and Lomax promotes mobility and accessibility as the cornerstones around which performance measures should be defined and upon which any sophisticated IMS should be based.

CHAPTER 4
ANALYSIS OF INTERMODAL PERFORMANCE MEASURES FOR FREIGHT MOVEMENT

Introduction

The objectives of this chapter are to examine intermodal freight performance measures and to identify the priorities given to these measures by State departments of transportation. The chapter presents goal and performance measures from fifteen States (Figure 4.1). All of the goals and their associated performance measures for freight movement are listed in Appendix A.

The survey of State DOTs identified a total of twenty-one goals related to intermodal freight movement. One additional goal was created as "Other." The goal labeled "Other" contains performance measures that did not readily fit under the first twenty goals.

The twenty goals and 211 performance measures, (excluding "Other") were compared for frequency of use by State DOTs. The comparisons include:

1. The number of States having similar measures under the same goal,
2. The number of total measures for each goal by State,
3. A discussion of similarities of those goals and measures used by a majority of the State DOTs,
4. Identification of the three most frequently used performance measures for each goal, and
5. A discussion of those goals and measures used by a minority of States, but which are important to the mandates of the ISTEA.

The 20 goal Statements have been ranked by frequency of use by State DOTs (Table 4.1). Of the fifteen DOTs surveyed, the same six goals are each used by at least six States. Goal number one was used by 11 States, goals number two, three and four were used by nine States. The three goals are ranked by the number of performance measures associated with a given goal.

Sixty-six percent, or 140 of the total 211 performance measures, are included within the top six goals (Table 4.1). These goals and performance measures are analyzed in greater detail to determine the priority given to them by the DOTs.

A breakdown of the six leading goals is presented in tabular form in Tables 4.2 through 4.7. Information in these tables identifies the number of performance measures developed by each State DOT.

Table 4.1 Ranking of Goals by Frequency of Use for Freight Movement	
Goal	**State**
1. Accessibility of intermodal facilities (internal and external measures)	*AZ FL KY HI IN MI MT NJ OK PA*
2. Availability of intermodal facilities	*AZ CA HI IN KY MT NJ OK TX*
3. Cost and economic efficiency	*CA HI KY MI MO MT NJ PA TX*
4. Safe intermodal choices	*CA HI IN MI MO MT NJ OK TX*
5. Connectivity between modes (ease of intermodal connection)	*AZ HI IN MI MT NJ OR*
6. Time	*AZ HI NJ NM OK OR*
Reliability of facility	HI NJ OR PA
Operational standards and productivity	MI NJ TX
Environmental protection	CA NJ TX
Legal and regulatory issues	OK OR NJ
Improve intermodal effectiveness of the transportation system	MO OK OR
Encourage an increase in the percent of intermodal or alternative mode trips where the change benefits the user	FL KY MO
Define strategies for improving the effectiveness of the modal interaction	MI MO OR
Ensure freight mobility	CA MT
Establishment of ongoing analysis of existing and future freight flows	OK TX
Economic development	CA NJ
Funding	TX
Improve public knowledge of intermodal travel opportunities	MO
Improve data availability an accuracy regarding intermodal trips	MO
Identify key linkages between one or more modes of transportation where the performance or use of one mode will affect another	MO

Discussion of the Six Leading Performance Measures

In terms of freight movement, the goal optimized by the State DOTs is the accessibility of intermodal facilities. Eleven of the fifteen States developed performance measures. (Table 4.1). Under this category, there is a clear division between internal and external performance measures. Internal measures deal with the operation of the intermodal facility, such as the number of vehicles accessing the intermodal facility.

External measures concern conditions indirectly affecting the intermodal facility, such as level of service on access roads. External performance measures under this category are by far the most numerous including 69 percent, or 29 of the 42 measures (Table 4.2). The measures in this category emphasize the following:

- Level of service,
- Actual conditions of a transportation route, and
- Bridge restrictions.

Internal performance measures developed by State DOTs include:

- Queuing of vehicles,
- Turning radius into facility, and
- Deficiencies of the intermodal facility.

Table 4.2 Goal: Accessibility of Intermodal Facilities

State	Number of Internal Performance Measures	Number of External Performance Measures
Arizona	0	2
California	0	0
Florida	2	3
Hawaii	1	5
Indiana	2	1
Kentucky	1	3
Michigan	0	0
Missouri	0	2
Montana	2	3
New Jersey	2	3
New Mexico	0	0
Oklahoma	1	3
Oregon	1	0
Pennsylvania	1	4
Texas	0	0
TOTAL	13	29

Nine State DOTs used the goal of availability of intermodal facilities. This goal contained the second largest number of performance measures. The main focus of the measures related to this goal is concerned with the capacity of the facility. Examples of capacity measures include:

- Volume-to-capacity ratios,
- Railroad track capacity, and
- Storage capacity.

New Jersey and Hawaii generated the most performance measures for this goal, with 42 percent, or 11 out of 26 total measures (Table 4.3).

Table 4.3 Goal: Availability of Intermodal Facilities

State	Number of Performance Measures
Arizona	2
California	1
Florida	0
Hawaii	5
Indiana	4
Kentucky	2
Michigan	1
Missouri	0
Montana	0
New Jersey	6
New Mexico	0
Oklahoma	4
Oregon	0
Pennsylvania	0
Texas	1
TOTAL	26

The third goal utilized by a large number of State DOTs was concerned with cost and economic efficiency (Table 4.1). The main focus of these performance measures is on the costs associated with:

- Cost per ton-mile by mode,
- Revenue costs, and
- Expenditures.

Pennsylvania and Texas developed the majority of these performance measures, with 11 of the 23, or 48 percent for this goal (Table 4.4).

Table 4.4 Goal: Cost and Economic Efficiency

State	Number of Performance Measures
Arizona	0
California	2
Florida	0
Hawaii	2
Indiana	0
Kentucky	1
Michigan	2
Missouri	1
Montana	1
New Jersey	3
New Mexico	0
Oklahoma	0
Oregon	0
Pennsylvania	7
Texas	4
TOTAL	23

Safe intermodal choices were the next goal identified. Nine States claimed this as a goal, although the actual States and number of performance measures differed from the previous goals. The majority of the State DOTs are concerned with:

- Number of accidents,
- Cost of accidents, and
- Number of fatalities.

Texas and Hawaii have the largest number of performance measures under this goal (Table 4.5), comprising 45 percent, or nine out of the total 20 measures.

Table 4.5 Goal: Safe Intermodal Choices

State	Number of Performance Measures
Arizona	0
California	1
Florida	1
Hawaii	4
Indiana	1
Kentucky	0
Michigan	1
Missouri	1
Montana	2
New Jersey	3
New Mexico	0
Oklahoma	1
Oregon	0
Pennsylvania	0
Texas	5
TOTAL	20

Ranked fifth for usage by State DOTs is the goal of connectivity between modes or intermodal ease of connection. Seven States have utilized this as a goal (Table 4.6). The performance measures for this goal focus mainly on:

- The number of facilities,
- Delay of trucks at facilities, and
- Travel times.

Hawaii and Indiana provided the largest number of performance measures under this category (Table 4.6). These two States developed eight of the total 18 measures for this goal.

Table 4.6 Goal: Connectivity between modes or intermodal connectivity ease of connection

State	Number of Performance Measures
Arizona	1
California	0
Florida	0
Hawaii	4
Indiana	4
Kentucky	0
Michigan	2
Missouri	1
Montana	3
New Jersey	2
New Mexico	0
Oklahoma	0
Oregon	1
Pennsylvani a	0
Texas	0
TOTAL	18

Six States developed performance measures associated with the goal that addressed time (Table 4.7). Measures identified by State DOTs related to this goal include:

- Total transfer time,
- Freight transfer time between modes, and
- Average travel time.

Hawaii and New Jersey provided the largest number of performance measures for this goal. Measures developed by these two States make up 56 percent, or five out of a total of seven measures.

Table 4.7 Goal: Time

State	Number of Performance Measures
Arizona	1
California	0
Florida	0
Hawaii	3
Indiana	0
Kentucky	0
Michigan	0
Missouri	0
Montana	0
New Jersey	2
New Mexico	1
Oklahoma	1
Oregon	1
Pennsylvani a	0
Texas	0
TOTAL	9

Discussion of Performance Measures Used by a Minority of State DOTs

This section discusses the goals and associated performance measures that were addressed by a minority of the State DOTs. Fewer than five State DOTs developed performance measures for each of the remaining 14 goals (Table 4.1). Of these 14 goals, six are recognized under the mandates of the ISTEA. These goals include:

- Environmental protection,
- Improvement of intermodal effectiveness,
- Definition of strategies for improvement of modal interaction,
- Analysis of existing freight flows,
- Economic development, and
- Improvement of public knowledge of intermodal opportunities.

Although not directly associated with the requirements of ISTEA, four of the eight remaining goals identify notable issues. The four goals contain performance measures developed by three to four of the State DOTs and include the following goals:

1. Increased reliability of facility,
2. Identification of operational standards and productivity,
3. Specification of legal issues and regulatory,
4. Encourage the increase in the percent of intermodal or alternative mode trips where the change benefits the user.

Conclusions

A major observation in the analysis was the lack of utilization of the twenty goals by the fifteen State transportation departments. There is not as much consistency in goal use as one might expect given the mandates of ISTEA. Considering the diversity of goals, and frequency of use indicates a disparate perspective by State DOTs in the development of freight performance measures.

The States surveyed placed a primary emphasis on the establishment of a goal and performance measure related to the accessibility of intermodal facilities. Subsequent goals and measures emphasized the availability, economics, and safety of intermodal facilities, respectively. This ranking falls in line with the mandates of ISTEA.

However, ISTEA also mandated that states consider environmental concerns and public participation in their planning processes. Performance measures that dealt with environmental concerns were addressed by three States, while measures involving public participation were addressed by only one State. Two States used economic development as a category for performance measures. This low level of utilization by State DOTs for these three goals indicates that environmental concerns, public participation and economic development were not a high priority in the development of performance measures.

Problems with the analysis of the performance measures were made difficult by the confusion between the definitions of a performance measure and a performance standard. An example of a performance measure would address the vertical clearance of bridges. In comparison, an example of a performance standard for this measure would be the requirement of a 21-foot minimum vertical clearance for double-stack trains.

Another problem was the vague language used in some performance measures. Many of the performance measures were ambiguous. It was unclear what problem the State DOT was attempting to identify with a particular performance measure.

CHAPTER 5
ANALYSIS OF INTERMODAL PERFORMANCE MEASURES FOR PASSENGER MOVEMENT

Introduction

The objectives of this chapter are to examine intermodal performance measures for passenger movement and identify the priorities assigned to these measures by State departments of transportation. All of the goals and their associated performance measures for passenger movement are listed in Appendix B.

This section presents goals and performance measures from fourteen States. There is a total of seventeen goals including one goal labeled "Other." Sixteen goals and 260 performance measures, excluding the "Other" were compared for frequency of use by the State DOTs. The comparisons include:

1. The number of States having similar measures under the same goal,
2. The number of total measures for each goal by State,
3. A discussion of similarities of those goals and measures used by a majority of the States,
4. The three most frequently used performance measures for each goal, and
5. A discussion of those goals and measures used by a minority of States, which are important to the mandate of the ISTEA.

The sixteen goals have been ranked by frequency of use by State DOTs in Table 5.1. Of the fourteen States surveyed, five goals are used by at least nine or more. Goal number one was used by eleven States and goal number two was used by ten States. Goal's three, four and five were used by nine States, however, the number of performance measures and state participation differ from these goals.

Of the 260 performance measures examined, 148 measures or 57 percent were contained in the five goals. The five goals and their performance measures are analyzed to determine the priorities that the State DOTs placed on specific intermodal passenger performance measures.

A breakdown of the five leading goals is presented in tabular form in Tables 5.2 through 5.5. The tables show the number of performance measures developed by each State DOT for each goal.

Table 5.1 Ranking of Goals by Frequency of Use for Passenger Movement	
Goal	**State**
1. Accessibility/Availability of intermodal facilities (internal and external measures)	*AZ CA FL HI KY MI NM OK OR PA TX*
2. Time	*AZ FL HI IN MI NM OK OR PA TX*
3. Safe intermodal choices	*CA FL HI OK OR MI MO PA TX*
4. System connectivity	*AZ FL HI IN MI OK OR PA TX*
5. Intermodal connectivity between modes	*AZ CA HI MI NJ NM OK OR PA*
Cost and affordability	CA HI KY MI OR PA TX
Encourage an increase in the percent of intermodal or alternative mode trips where the change benefits the user	CA KY MI MO OK TX
Improve intermodal effectiveness of the transportation system	CA MO OR PA TX
Define strategies for improving the effectiveness of the modal interaction	CA MI MO
Improve public knowledge of intermodal travel opportunities	MO OR PA
Improve data availability an accuracy regarding intermodal trips	MO OR PA
Legal issues and regulatory	MI OR
Reliability of facility	HI OR
Identify key linkages between one or more modes of transportation where the performance or use of one mode will affect another	MI MO
Environment	TX
Funding	TX

Discussion of the Five Leading Passenger Performance Measures

The goal of accessibility/availability of intermodal facilities contained the largest number of performance measures and included the greatest participation with 11 of 14 States.

This goal is separated into the two categories of internal and external measures. They are consistent with the comparable freight movement goal. Internal measures address the actual conditions of the intermodal facility, such as queuing of vehicles. External measures included indirect conditions, such as traffic volume on roads.

Of the 57 total measures for this goal, 82 percent, or 47 of the measures, are classified as external, with Texas providing a majority of the measures (Table 5.2). The overall focus of the external measures was on:

- Level of service,
- Traffic volume, and
- Access to the intermodal facility.

Internal measures emphasize the following issues:

- Queuing of vehicles,
- Pedestrian and bicycle access to and from intermodal facility, and
- Facility service area.

Table 5.2 Goal: Accessibility/availability of intermodal facilities

State	Number of Internal Performance Measures	Number of External Performance Measures
Arizona	1	2
California	0	1
Florida	0	2
Hawaii	0	7
Indiana	0	0
Kentucky	1	4
Michigan	3	2
Missouri	0	0
New Jersey	0	0
New Mexico	0	1
Oklahoma	2	2
Oregon	1	2
Pennsylvania	0	2
Texas	2	22
TOTAL	10	47

The second goal assigns a high priority to time and related measures. This goal accounts for 3 percent of the total performance measures. Measures for this goal emphasize the following issues:

- Average travel time,
- Delay time for all modes, and
- On-time performance.

Texas and New Mexico provide the largest number of performance measures with a combined total of nine performance measures (Table 5.3).

Table 5.3 Goal: Time

State	Number of Performance Measures
Arizona	1
California	1
Florida	1
Hawaii	2
Indiana	1
Kentucky	0
Michigan	2
Missouri	0
New Jersey	0
New Mexico	4
Oklahoma	1
Oregon	1
Pennsylvania	3
Texas	5
Total	22

The provision of safe and secure intermodal choices was the Goal ranked third most by State DOTs. However, while ranked third among State participation, this goal contains the second largest number of performance measures with 44 out of 260 measures. Eight States developed measures (Table 5.4) for this goal including:

- Number of accidents, injuries and fatalities by vehicle miles for all modes,
- Security measures and conditions, and
- Percent change in Statewide accidents.

Texas supplied the majority of the measures at 20, or 45 percent of the total measures.

Table 5.4 Goal: Safe and secure intermodal choices

State	Number of Performance Measures
Arizona	0
California	1
Florida	2
Hawaii	3
Indiana	0
Kentucky	0
Michigan	1
Missouri	1
New Jersey	0
New Mexico	0
Oklahoma	5
Oregon	3
Pennsylvania	8
Texas	20
TOTAL	44

The goal of system connectivity ranks fourth in number of performance measures. Nine State DOTs developed measures that stress the following:

- Number of parking spaces,
- Layover time for all modes, and
- Volume-to-capacity ratio per hour of parking spaces.

Hawaii and Oregon contributed 50 percent, or 14 of the 28 measures that addressed the Goal of system connectivity (Table 5.5).

Table 5.5 Goal: System Connectivity

State	Number of Performance Measures
Arizona	3
California	0
Florida	1
Hawaii	9
Indiana	3
Kentucky	0
Michigan	2
Missouri	0
New Jersey	0
New Mexico	0
Oklahoma	2
Oregon	5
Pennsylvania	2
Texas	1
Total	28

The goal of intermodal connectivity between modes ranks fifth in number of performance measures (Table 5.1). Nine State DOTs provide performance measures for this goal that highlight:

- Transfer time between modes,
- Intermodal facility connectivity, and
- Travel delay.

Pennsylvania provides the largest number of performance measures, with a total of five out of the total of sixteen measures (Table 5.6).

Table 5.6 Goal: Intermodal connectivity between modes

State	Number of Performance Measures
Arizona	1
California	2
Florida	0
Hawaii	2
Indiana	0
Kentucky	0
Michigan	2
Missouri	0
New Jersey	1
New Mexico	1
Oklahoma	1
Oregon	1
Pennsylvania	5
Texas	0
Total	16

Discussion of Performance Measures Used by a Minority of State Departments of Transportation

This section discusses the goals and their associated performance measures that were identified by a minority of the State DOTs included in the survey. Fewer than seven States developed performance measures for each of the remaining eleven goals (Table 5.1). Of the eleven goals, five are important when compared to the mandates of the ISTEA. The goals are:

- Improve the intermodal effectiveness of the transportation system,
- Define strategies for improving the effectiveness of the modal interaction,
- Improve public knowledge of intermodal opportunities,
- Improve data availability and accuracy regarding intermodal trips, and
- Consider environmental concerns.

While not directly associated with the mandates of the ISTEA, three of the remaining six goals identify critical transportation issues. The five goals contain performance measures developed by fewer than six State DOTs. They include:

- Consider cost and affordablity factors,
- Identify legal and regulatory issues, and
- Improve reliability of the intermodal facility.

Chapter Summary

It is apparent that State departments of transportation have diverse perspectives on the development of performance measures for passenger movement. This is illustrated by the lack of utilization of the sixteen goals by the State DOTs.

The primary emphasis of the State DOT workplans examined in this survey was to establish goals and related performance measures that addressed the accessibility/availability of passenger intermodal facilities. The subsequent goals and measures rank time, safety, system connectivity, and intermodal connectivity between modes, respectively. This grouping of goals is commensurate with the mandates of the ISTEA.

The ISTEA also requires that State DOTs consider environmental concerns and public participation in their planning processes. The performance measures that focused on public participation were addressed by only three States. The topic of environmental concern was used by only one State Performance measures emphasizing economic development are also included in the ISTEA mandate. However, as far as passenger intermodal goals are concerned, economic development is not a high priority by State DOTs. There was, however, one State DOT that included a performance measure that identified "number of jobs supported" under the goal of cost and affordability.

The analysis of the passenger performance measures was made difficult by the confusion of the States between the definitions of performance measures and performance standards.

The language of the performance measures was also a problem. Many of the performance measures are vague. It is often unclear as to what problem the State DOT was attempting to identify with a given measure. The ambiguity of some of the measures will complicate the development of associated performance standards in the future.

An overriding theme present in the passenger movement performance measures is their primary focus on vehicle movement rather than person mobility. This is contrary to the theme of the ISTEA which attempts to focus to focus on the movement of people.

Conclusions

This report discusses three topics related to the development and use of performance measures by State DOTs to improve intermodal transportation systems. They include:

1. The role of performances measures in the planning process;
2. A clarifications of what performance measures are and their potential uses and;
3. The development of performance measures by 15 State DOTs.

In order to make performance measures meaningful, the confusion between performance measures and performance standards must be eliminated. A standard, as identified in Chapter One, is A DESIRED LEVEL of system performance. A performance measure is ANY MEASURE of system performance. Both must be used to determine if a system meets the objectives and goals of the planning process. Performance measures in combination with performance standards can be used to evaluate static situations--the level of performance at a given point in time. They can also be used to evaluate dynamic situations--performance over time.

Performance measures have sparked a lively debate among users about their role in the planning process and how they are to be used. The location of performance measures near the beginning of the planning process provides an extra impetus to evaluate the effectiveness of a transportation system. Although the inclusion of performance measures does not drastically change the form of the planning process, its inclusion is significant.

Placing performance measures at a step early in the planning process emphasizes the need for evaluation. This makes evaluation more important and makes the planning process results oriented.

The academic and agency research reviewed in this report identifies a number of goals and performance measures for intermodal centers and activities. The central message from this research is that the development of a performance-based transportation system is the result of an evolutionary process. In the beginning the goals, objectives and performance measures must be simple and straight forward. As the system evolves, the goals and objectives should be refined and the performance measures become more sophisticated. Ultimately, the planning process should be directed at improving personal and freight mobility, as well as providing a higher level of accessibility within a community.

There are both long term and short term goals and measures. The survey of State DOTs also identified a number of long and short term goals and measures. It is important that the time component of the goals, objectives, and performance measures be recognized and placed into the proper chronological sequence. The correct ordering of these items allows DOTs to implement short term items first and long terms items at a later date.

The goals and objectives selected by the State DOTs in this report show a remarkable amount of consistency for both freight and passenger movement. The following topics: accessibility and availability of intermodal facilities, time, safety, and system connectivity, were used for both passenger and freight goals. The "cost" goal was used in the freight goals, but not for passenger goals. All of the topics are indicative of the transportation system planning requirements in the ISTEA. Interestingly, requirements like environmental quality and public participation rarely appeared in the goals of the States surveyed for this report even though they too are part of the ISTEA.

Although there was consistency among many performance measures from the different State DOTs, there was also a great deal of diversity. There were a number of measures that were used only by two States. For example...The limited use of some measures and widespread of others demonstrate that some performance measures can be used for all transportation systems – global measures. There are also unique characteristics of transportation systems and special needs of State departments of transportation that necessitate the design of measures for that system only -- specific measures. The existence of the specific measures from the State DOTs may also indicate differing approaches to evaluation of transportation systems.

The development of performance measures for freight and passenger movement represents a major step forward for State DOTs. Now, the task is to use and refine them to improve the ability of transportation systems to move people and goods more efficiently.

Bibliography

________. Interim Final Regulations. Federal Highway Administration and the Federal Transit Administration. December 1, 1993.

________.Highway Capacity Manual. Third Edition, Special Report 209. Transportation Research Board, Washington, D.C., 1994.

Barton-Aschman Associates, Inc., Intermodal Management System for the Metropolitan Phoenix Area. Undated.

Booz, Allen and Hamilton, Inc. with Caltrans, Intermodal Transportation Management System. 1995.

Cambridge Systematics, Inc. with Barton-Aschman Associates, Inc., Analytical Procedures to Support a Congestion Management System. March 1994.

Dye Management Group, Inc. with Oregon Department of Transportation, Approach to Designating Oregon=s Intermodal System. 1993.

Ismart, Dane, Intermodal Management Systems: Technical Guidelines. Federal Highway Administration, Intermodal Division. Washington, D.C. Undated.

Jones, David W., Intermodal Performance Measures for the Bay Area Transportation System. January 1995.

Louisiana Transportation Research Center (LTRC), Defining Performance Measures for an Intermodal Management System. April 1994.

Meyer, Michael D., Transportation Research and Education Center, Georgia Institute of Technology, Basic Concepts to Guide Assessment of Statewide Intermodal Planning. May 1994. (Secondary source for State of Florida).

Moore, Terry., "Planning without Preliminaries." Journal of the American Planning Association. 54, 4: 525-528.

National Highway Institute, The Management Systems: Intermodal and Public Transportation (A Three Day Technical Course). June 1995.

Norris, Bahar B., Intermodal Performance Standards: A Primer for Transportation Planning Practitioners. Volpe Transportation System Center, Cambridge, Massachusetts. July 1994.

Poorman, John P., Capital District Transportation Committee, The Metropolitan Congestion Management System and Freight Issues. December 1993.

Pratt, Richard H. and Timothy J. Lomax, Performance Measures for Multimodal Transportation Systems. January 1994.

Weiner, Edward. Urban Transportation Planning in the United States A Historical Overview. U.S. Department of Transportation, Office of the Secretary, Washington, D.C. February, 1986.

Woolpert, John with Ohio Department of Transportation, Access Ohio. 1993.

Glossary

External Performance Measure - measure concerned with conditions indirectly affecting an intermodal facility.

Goal - a general written expression of a desired outcome.

Intermodal Planning - process that focuses on the integrated use of different types of transportation modes.

Internal Performance Measure - statement that deals with the operation of the intermodal facility.

Objective - a written expression of a specific end to be achieved through some form of action.

Performance Measure - an indicator of system performance.

Performance Standard - a gauge to determine the level of system performance.

APPENDIX A: INTERMODAL PERFORMANCE MEASURES

FREIGHT MOVEMENT

This appendix provides a list of specific performance measures for the transport of freight. They were extracted from the workplans of 15 State departments of transportation. The measures are grouped by goals which are derived from the same documents. The abbreviations in parentheses (NJ, MI, AZ) indicate the States that have included a given performance measure in their work plans.

1. Accessibility of intermodal facilities

Truck turnaround time at intermodal terminals (NJ)

Drayage distance (NJ)

Average drayage time/delays (minutes) (NJ)

Average drayage costs ($ per lift) (NJ)

Customs delays (hours per shipment) (NJ)

Numbers accessing facility (FL)

Queuing of vehicles and its relationship to overall delay (OR)

LOS on access roads (HI, KY)

LOS at intersections serving the facility (HI)

Corridors below level of service C (MT)

Congestion level on access highways (AZ)

Traffic volume on access roads (HI, AZ)

Volume to capacity ratios (MT)

Fluctuations in traffic volumes (KY)

Geometrics of connector link (HI)

Pavement condition on connector link (HI, KY, OK, FL)

Perceived deficiencies (HI)

Proportion of freight traffic at facility on portion of network (KY)

Horizontal clearance (FL)

Vertical clearance bridges viaducts and overpasses (OK, FL, NJ)

Number of structures lacking 21' vertical clearance and number of structures lacking 15'6" of horizontal clearance between major cities (IN)

FRA classification for posted speed limited from freight yard to a major railroad (IN)

Amount of turning radius (FL) from major highway into the inventoried facility (IN)

Bridge weight limits (OK)

Truck delivery and loading interference with street traffic (OK)

Track conditions (MT)

User identification of access issues (MT)

Percent of highway system with bridges that are structurally deficient or functionally obsolete (MT)

Weight restrictions for bridges (PA)

Vertical clearance > 20' 6" (PA)

Turning radii (PA)

Existence of railroad electrification (PA)

Remaining life of pavement (PA)

Available highway access by mode (MI)

Capacity deficiency (MI)

2. Availability of Intermodal facilities; Pick-up-delivery system

Number of T.E.U.'s (10' x 21') that can be stored on the premises of the intermodal terminal facility (IN)

Number of railroad cars (hopper type) that can be stored on the premises of bulk transfer facility (IN)

Number of trucks that can be loaded with bulk material per hour of loading time (IN)

Type of modes handled (KY, NJ)

Facility service area (KY)

Freight dock availability at major activity centers (OK)

Average dwell time (OK)

Vehicle queuing (OK)

Volume to capacity ratios (OK)

Loft capacity (annual volume (NJ)

Track capacity (size, acreage) (NJ)

Gate facilities (queuing length, wait time) (NJ)

Equipment availability (NJ)

Container storage capacity (NJ)

Number of intermodal facilities (TX)

Modal choice (HI, AZ)

Time of transfer (HI)

Distance of transfer (HI, OK)

Capacity Restrictions (HI)

Perceived deficiencies (HI)

Industry identification of major barriers by corridor (MT)

Average cargo/luggage transfer time (HI-airport)

Access time (AZ)

Distance in miles (IN)

Tons transferred per hour, average transfer time, capacity utilization (V/C) for access roads (CA)

System condition (MI)

3. Cost and Economic Efficiency

Cost per ton-mile by mode (NJ)

Revenue per ton-mile by mode (NJ)

Operating ratio (NJ)

Average cost per trip (HI)

Average cost per ton mile (includes change in lost time) (CA)

Maximum weight for restrictions (PA)

Average cost per mile (HI)

Maintenance cost of connector link (KY)

Cost per fuel mile as it compares to cost per air mile (rail, water) (MO)

Cost by commodity (MT)

The degree to which private sector investment continues to serve as the principal source of funding for pipeline development and operation in Texas (TX)

Expenditures for freight rail (TX)

Revenue ton-miles (TX)

Ton mile expenses (TX)

Additional costs per trip (user fees) (PA)

Reduced cost per trip (subsidies) (PA)

Insurance costs (PA)

Speed limits and difference between modes (PA)

Number of restricted routes, additional mileage, increased costs (PA)

Hours of access lost (PA)

AEC/ton mile (CA)

Expenditures to retire deficiencies (MI)

Nonmotorized expenditures (MI)

4. Provide users with safe and secure intermodal choices

The dollar value of property loss in accidents per 100,000 users of transfer points (MO)

Number of accidents per movement (MT)

Number of accidents per million VMT (HI)

Accident rate (NJ) per million vehicles of exposure (IN)

Average accident cost (property, injury, death) per trip (HI)

Number of accidents (reportable incidents=FL) year (HI)

Number of accidents involving hazardous waste (NJ)

Number of accidents per trip (HI)

Railroad - Highway Safety Crossings (OK)

Accident rate, deaths, injury, property loss by type of corridor (MT)

Allowable size of trailer (NJ)

Number of accidents and facilities occurring at grade crossings (TX)

Number of fatalities and injuries occurring on the rail system (TX)

Ton miles per accident (TX)

Shipping accidents occurring on waterways (TX)

Ratio of oversize/overweight permit fees collected to dollar value of damage caused (TX)

Accidents per 1,000,000 ton miles (CA)

Grade crossing safety improvement (MI)

5. Connectivity between modes or intermodal connectivity ease of connection

Time and distance of transfer time between modes to be "n" minutes and "x" feet (OR)

Number of facilities (MT)

Number of open access facilities (percent of all facilities (MT)

Delay of trucks at facility per VMT (HI)

Frequency and length of delays (disruption/blockage) (MT)

Average transfer time between modes (HI)

Amount of time required to make a direct transfer of a bulk freight commodity from ship or barge (IN)

Amount of time required to transfer T.E.U.'s from one mode to another per hour (IN)

Capacity restrictions for cargo at intermodal facilities (HI)

Perceived deficiencies (HI)

Travel Delay (AZ)

Interference of movement at grade crossings—delay time and speed (NJ)

Average delay time at railroad crossings or draw bridge opening on highway arterioles and collectors accessing such locations when gates are down (IN)

Travel time by a semi with a 53' trailer, in number of minutes from terminal to macro corridor highway route (IN)

Prioritization of track usage (NJ)

Adequacy of highway connection by mope (MI)

Activity center by mode (MI)

6. Time

Average travel time between facility and major destination (HI,NM) by mode (OR)

Average travel time from facility to major highway network (on connector link) (HI, NJ)

Average travel time from facility to rail (on connector link) (NJ)

Average travel time between facility and major destination (HI)

Total travel time (AZ)

Freight transfer time between modes (OK)

7. Reliability of facility

Percentage of scheduled ship and truck departures that do not leave within an acceptable time limit (HI)

Percentage of airline and scheduled ground transportation arrival/departures not within specified time limits (OR, HI)

Roadway and modal level of service (OR, NJ)

Delay time created by drayage (PA)

Miles between modes (PA)

Time for delivery and unloading (PA)

Percent delivered off-peak time (PA)

8. Operational Standards and Productivity

Line haul speed (NJ)

Percentage on-time performance (NJ)

Availability of real-time cargo information (NJ)

Double stack capacity (NJ)

Primary intermodal service schedule adherence (NJ)

Secondary services status report (NJ)

The degree to which pipeline segments are protected against deterioration during periods of under utilization in order to ensure that pipeline deterioration does not harm local and regional economies (TX)

Percent change in truck traffic at border crossings (TX)

Percent change of tonnage moved on the various transportation components (TX)

Number of intermodal facilities (TX)

Total tons miles transported by freight rail (TX)

Number of carloads handled (TX)

Facility usage by mode (volume/capacity) (TX)

Production area utility by mode (MI)

9. Environmental Protection

Air quality/congestion reduction (NJ)

Expansion capability (NJ)

Fuel usage (NJ)

Constraints to utilization due to noise (hours of operation) (NJ)

Constraints to utilization due to water quality (dredge fill permits) (NJ)

Restrictions on hazardous waste transport (NJ)

The degree to which pipeline spills and accidents are minimized to protect the environment (TX)

10. Legal and regulatory issues

Railroad freight liability for passenger railroad usage (OK)

Limitations to use of facilities by carriers (OR)

Evaluate mechanisms for public private negotiated agreements including service sharing between carriers types (OR)

Weight Restricted Areas (NJ)

Hours of operation (NJ)

11. Improve intermodal effectiveness of the transportation system

Vehicle miles traveled (OR)

Number of significant (>50,000 for MPOs; >25,000 in small urban areas; >5,000 in rural areas) intermodal transfer points in the State (MO)

Number of users of transfer points (MO)

Percent of street traffic delivered off-peak (OK)

12. Encourage an increase in the percent of intermodal or alternative mode trips where the change benefits the user

Landside Gross Tonnage (FL)

Percent of change in mode splits (MO, FL)

Modal interchange (KY)

13. Define strategies for improving the effectiveness of the modal interaction

Cost / benefit of existing capacity vs. new construction (OR)

Increase in percentage of informational and data exchanged between intraState agencies (MO)

Percent of intermodal connecting points and facilities accurately placed on a map (MO)

Flow time in minutes as it compares to the number of connecting transfers (MO)

To provide users safe, secure, cost efficient, and timely options of transportation (MO)

System impedance removed - linear and point (MI)

Border delays due to inspection services (MI)

14. Ensure Freight Mobility

Average daily traffic (MT)

Tons hauled (MT)

Commodities hauled/shipped (Number of tons) (MT)

Number of rail cars (Number of tons) (MT)

Mobility index (Ton miles\ vehicle miles) * average speed (CA)

Lost time (per trip or mile) (CA)

15. Establishment of ongoing analysis of existing and future freight flows

Customs and administrative processing time (OK)

Tons of freight rail transport originating and terminating in Texas (TX)

16. Economic Development

Market share of international or regional trade by mode (NJ)

Direct and indirect jobs created (NJ)

Percent of State gross product (NJ)

Jobs supported (CA)

GAP impacts (CA)

Economic costs of pollution, accidents, fatalities and lost time (CA)

Change in tons of pollution (CA)

Change in tons of greenhouse gases (CA)

Change in fuel consumption per ton mile (CA)

17. Funding

Airport improvements and cost scheduled at airports (TX)

The degree to which private sector investment continues to serve as the principal source of funding for pipeline development and operation in Texas (TX)

Number of intermodal facilities in which TxDOT assists in development (TX)

18. Improve public knowledge of intermodal travel opportunities

Percent of State residents aware of intermodal opportunities (MO)

Percent increase in intermodal facilities use (MO)

19. Improve data availability and accuracy regarding intermodal trips

Percent of error free data in IMS database (MO)

20. Identify key linkages between one or more modes of transportation where the performance or use of one mode will affect another

Average number of users using intermodal options (MO)

Cost per ton for freight movement and average time of transfer from one mode to another (MO)

21. Other

Miles of track by FRA classification (TX)

Track miles in operation (TX)

Track miles under threat of abandonment (TX)

Track miles abandoned (TX)

Percent change in crime at rest areas and other facilities (TX)

Ton mile per capita, value per ton (CA)

Number of facilities meeting federal or State system plan standards (MI)

APPENDIX B: INTERMODAL PERFORMANCE MEASURES

Passenger Movement

This appendix provides a list of specific performance measures for intermodal passenger movement. It is based on the work plans of 14 State departments of transportation. The measures are groups by Goals which have been obtained from the same work plans. The abbreviations in parentheses (MI, MT, FL) indicate the States which have included a given performance measure in

Airports within a 30-minute drive of agricultural centers capable of supporting twin engine piston powered aircraft. (TX)

Percent of population with access to fixed route transit services (TX)

Passengers per capita within urban service area (TX)

Passengers per vehicle mile in rural areas (TX)

Percent of rural citizens with public service available (TX)

Percent of elderly and disabled persons with special transit available (TX)

Percent change in the number of public transportation trips (TX)

Population of urban and rural areas with direct access to passenger rail and bus services (TX)

Number of passengers traveling on intercity rail and bus system (TX)

Number of modes available (PA)
V/C ratio or LOS (CA)

Available highway access by mode (MI)

Capacity deficiency (MI)

Transportation availability by mode (MI)

Facility utility (MI)

Facility usage by mode (MI)

Percent highway system mainline pavement mileage rated good or better (TX)

Percent change in general aviation airport pavement condition index (TX)

Vehicle miles traveled within urban areas (TX)

Average vehicle occupancy within urban areas (TX)

Passenger miles traveled per capita (TX)

2. Time

Average travel time between facility and major destination (HI,NM, PA) by mode (OR)

Highway delay at major railroad crossings (OK)

Average (peak hour (FL)) travel time from facility to major highway network (on connector link) (HI, PA)

Total travel time (AZ, NM)

Average walking/riding time from center of parking facility to the terminal (IN)

Person hours of travel (NM)

Measure competitiveness of total travel times (NM)

On-time performance measure of public transit vehicles (TX)

Change in travel time (TX)

Average minutes of wait time to board ferry boat at Galveston and Port Aransas (TX)

Delay time at primary commercial airports (TX)

Average commuting time for urban population (TX)

Community service frequency by mode (weekly departures or arrivals) (MI)

On-time performance - by passenger mode (MI)

Travel time to/from facility (PA)

Lost time due to congestion (per trip or mile) (CA)

3. Provide users with safe and secure intermodal choices

Crimes per 1,000 passengers (OR)

Accidents per 1,000 vehicles at park and ride lots (OR)

Accidents per passenger mile (OR)

The number of people fatally injured per 100,000 users of transfer points (MO)

Number of accidents per million VMT (HI)

Average accident cost (property, injury, death) per trip (HI)

Number of accidents (reportable incidents = FL) per trip or year (HI)

Number of vehicles involved per 100,000 compared to other like facilities (FL)

Railroad /highway crossings (OK)

Pedestrian crossings (OK, PA) and sidewalks (PA)

Bicycle crossings/joint use (OK)

Fatalities and injuries per vehicle mile traveled (OK)

Accidents per vehicle miles traveled Fatalities and injuries per vehicle mile traveled (OK)

Percent change in Statewide traffic accident deaths (TX)

Percent change in Statewide accident, injury and fatality rates (TX)

Number of high accident locations (TX)

Percent of emergency road class that get through to TxDOT (TX)

Percent of drivers complying with seat belt law (TX)

Percent change in the proportion of driving while intoxicated fatal accidents to total fatal accidents. (TX)

Change in work zone accidents (TX)

Number of accidents and facilities occurring at grade crossings (TX)

Fatalities and injuries from waterborne transport (TX)

Number of general aviation airports meeting safety/compliance (TX)

Airports designed to applicable federal and State planning and design standards (TX)

Number of fatalities and injuries caused by air transportation (TX)

Number of accidents per month or per number of vehicle miles traveled (TX)

Average number of total miles between mechanical road calls per month (TX)

Number of intercity rail and bus accidents (TX)

Accidents per 1000 passenger miles (TX)

Percent change in accidents and fatalities on system and off system railroad grade crossings used for passenger rail services (TX)

Number of bicycle accidents and fatalities (TX)

Number of pedestrian accidents and fatalities (TX)

Percentage increase in the use of safety equipment by bicyclists (TX)

Number of Secured parking areas existence or non-existence of (PA)

Lighting and security staff (PA)

Lighted parking spaces (PA)

Number of accidents (PA)

Fatality/Injury rate of accidents (PA)

Opinion polls addressing perceived personal safety (PA)

Accidents per person mile (or 1,000,000 person miles) (CA)

Grade crossing safety improvement (MI)

4. System Connectivity

Minimum layover times (OR)

Parking spaces available loading/unloading by autos (OR)

Parking spaces per passenger (OR, PA-all, HI-airport)

Parking spaces per boarding (HI-transit)

Modal choice (HI, AZ)

Distance of transfer (HI)

Capacity Restrictions (HI, FL)

Perceived deficiencies (HI)

Layover time (OR, HI-airport)

Volume to capacity ratio per hour of parking spaces during daily peak periods—bus or rapid rail (IN)

Volume to capacity ratio per hour of parking spaces during daily peak periods—park and ride lots (IN, OK)

Volume to capacity ratio per hour of parking spaces during daily peak periods—airports, transit terminal intercity rail (IN)

Measure of waiting time (HI-transit)

Measure of bicycles per boarding (OR, HI-transit)

Average minutes of wait time to board ferryboat at Galveston and Port Arenas (TX)

Access time (AZ)

Cumulative travel time between a terminal and the closest major business center by mode type (OK)

Access to/from major intermodal passenger terminals and major population and activity centers (OK)

Number of pick up and discharge areas for passengers (PA)

Activity center utility by mode (MI)

Connectivity deficiency (MI)

5. Cost and affordability

Cost of intermodal trip as a percent of cost of auto use (OR)

Cost / benefit of existing capacity vs. new construction (OR)

Average cost per trip (HI)

Average cost per mile (HI)

Maintenance cost of connector link (KY)

Operating cost per passenger for urban transit systems (TX)

Cost per vehicle mile in rural areas (TX)

Operating cost per revenue mile, for urban transit systems (TX)

Cost per passenger mile in rural areas (TX)

Vehicle operating cost reductions (TX)

Expenditures for freight rail (TX)

Operating cost per revenue mile (TX)

Operating cost per passenger (TX)

Cost per passenger mile (TX)

Value of fuel savings (TX)

Cost of accidents per 1,000 miles (TX)

Cost of rail related air pollution per passenger miles or 1,000 miles (TX)

Additional cost per trip for user fees (PA)

Reduced cost per trip using subsidies (PA)

Insurance Costs and degree of liability (PA)

Speed limits and differences among modes (PA)

Cost per vehicle for parking fees (PA)

AEC/person mile (owner cost) (CA)

Use cost /person mile (user cost) (CA)

Jobs supported (CA)

GAP impacts (CA)

Economic cost of pollution, accidents, fatalities and lost time (CA)

Person per mile per capita, vehicle mile per capita, fuel consumption per capita (CA)

Expenditures to retire deficiencies (MI)

Nonmotorized expenditures (MI)

Average cost per lane mile constructed for asphaltic seal coat surfacing (TX)

6. Encourage an increase in the percent of intermodal or alternative trips where the change benefits the user

Percent of change in mode splits (MO)

Modal interchange (KY)

Number of modal choices (OK)

Percent increase in intermodal facilities use (TX)

Percent change in passenger miles traveled per capita (TX)

Percent change in the number of public transportation trips (TX)

Total passenger miles traveled for intercity rail service (TX)

Number of passengers traveling on the intercity rail and bus system (TX)

Accessibility (choice of modes for corridors and intermodal transfer facilities) (CA)

Personal Intercity modal choice (MI)

Personal Regional modal choice (MI)

7. Improve intermodal effectiveness of the transportation system

Volume to Capacity ratios for bicycles and pedestrian facilities (M0)

Number of significant (>50,000 for MPOs; >25,000 in small urban areas; >5,000 in rural areas) intermodal transfer points in the State (MO)

Number of users of transfer points (MO)

Vehicle miles traveled (OR)

Distance between service facilities and major activity centers (OR)

Percent change in person miles of travel by mode (TX)

Percentage of demand response trip requests (TX)

Distance between modes (PA)

Capacity utilization (v/c) for access roads (CA)

8. Define strategies for improving the effectiveness of the modal interaction

Increase in percentage of informational and data exchanged between intraState agencies (MO)

Percent of intermodal connecting points and facilities accurately placed on a map (MO)

Flow time in minutes as it compares to the number of connecting transfers (MO)

To provide users safe, secure, cost efficient, and timely options of transportation modes (MO)

Cost per fuel mile as it compares to cost per air mile (rail, water) (MO)

Mobility index: PMT/VMT * avg. speed (CA)

System impedance's removed - linear (MI)

System impedance removed - point (MI)

Change in commute travel person miles and vehicle miles traveled per telecommuting occasion (TX)

Change in total travel person miles and vehicle miles traveled per telecommuting occasion (TX)

9. Improve public knowledge of intermodal travel opportunities convenience/benefit maximization

Percent of State residents aware of intermodal opportunities (MO)

Make available intermodal ticketing and luggage transfers (OR)

Knowledge of existing and updated service information to all passengers (OR)

Existence of information services and ticketing (PA)

Existence and hours per week of processing time of customs and administrative processing (PA)

Existence of signage and number of miles per mile (PA)

Existence of handicap access and accessibility to all areas (PA)

10. Improve data availability and accuracy regarding intermodal trips

Percent of error free data in IMS database (MO)

Percent change in the number of people provided service at travel information centers (TX)

System condition (MI)

11. Legal Issues and Regulatory

Limitations to use of facilities by carriers (OR)

Evaluate mechanisms for public private negotiated agreements including service sharing between carriers types (OR)

Border delays due to inspection services (MI)

12. Reliability of the facility

Percentage of airline and scheduled ground transportation arrival/departures not within specified time limits (OR, HI)

Roadway and modal level of service (OR)

Percent of transit bus routes within specified time limits (HI)

Bus Headways (HI)

13. Identify key linkages between one or more modes of transportation where the performance or use of one mode will affect another

Number of users employing intermodal options (MO)

Adequacy of highway connection by mode (MI)

14. Environment

Change in vehicle emissions (TX)

Percent change in on road mobile source emission level within nonattainment areas (TX)

Percent change in VOC and Nox emissions (TX)

Number of urban areas classified as nonattainment status (TX)

Population living in urban areas classified as nonattainment areas (TX)

15. Funding

Percent change in flexible federal funding programmed for non highway projects (TX)

Airport improvement and cost scheduled at airports (TX)

Percent of general aviation needs funded (TX)

Fare recovery rate of urban transit systems (TX)

Number of intermodal facilities in which TxDOT assists in development (TX)

16. Intermodal Connectivity between modes

Transfer times between modes (OK, PA, CA)

Transit time between modal terminals (NJ)

Average transfer time between modes (HI, CA)

Transfer time between modes to be "n" minutes and "x" feet (OR)

Perceived deficiencies (HI)

Travel Delay (AZ, NM)

Existence of baggage transfer services between modes (PA)

Transfer time (PA)

Congestion measures (PA)

Waiting times between modes (PA)

Modal connection time (MI)

Passenger terminal connectivity (MI)

17. Other

Percentage of all trips made by bicycling and walking (TX)

Percent change in State urban principal arterial highway performance based on HPMS ratings (TX)

Average speed of travel (TX)

Volume to capacity ratios (TX)

Passenger miles traveled per capita (TX)

Tourist/recreation area utility by mode (MI)

Number or miles of nonmotorized facilities (MI)

*Measures included in the report are those reported for all modes only.

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