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Multimodal Transportation: Development of a Performance-Based Planning Process

This NCHRP digest documents Phase I of NCHRP Project 8-32(2), Multimodal Transportation: Development of a Performance-Based Planning Process. It also presents an action plan for Phase II of the research, NCHRP Project 8-32(2)A, which will produce a guidance manual for staff DOTs, MPOs, and other transportation planning organizations. This digest was prepared by the staff of Cambridge Systematics, Inc. The Principal Investigator for the project was Steven Pickrell of Cambridge Systematics, Inc.

INTRODUCTION

In recent years, national transportation policy has evolved to support the development of multimodal systems and services tailored to local conditions for improved efficiency and performance. This digest describes how performance-based transportation planning and decision making can be established to effectively guide transportation investment and operational decisions. It is intended to assist transportation planners, policy officials, and other practitioners in improving the transportation planning processes at the state, metropolitan, and local levels.

NCHRP Project 8-32(2), *Multimodal Transportation: Development of a Performance-Based Planning Process*, was conceived to support a new era of transportation planning efforts at the federal, state, and regional levels. The impetus for these planning efforts is a series of factors that have not only increased awareness of a more broad range of goals and objectives for transportation, but have helped to identify the diverse customers that the system must serve. These factors include

- The legislation in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and its reauthorization, the Transportation Equity Act for the 21st century (TEA-21), with their emphasis on multimodal solutions and their provisions on long-range planning, financial planning, management systems, and flexible funding;
- Heightened concern about the most effective use of scarce resources in an era when traditional transportation funding sources are not generating sufficient revenue to meet perceived needs, and general public opinion is tending toward a "tax revolt";
- Increased awareness and concern about the role of transportation in supporting economic competitiveness plus changes in the national and global economies that place new demands on the transportation system, especially for freight and goods movement;
- Environmental laws and regulations, particularly the Clean Air Act and Energy Efficiency Act;
- Social and equity concerns reflected in legislation such as the Americans with Disabilities Act;
- Growth management, congestion management, transportation/land use laws and regulations; and
- A variety of new technologies offering a wider range of transportation solutions

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including Intelligent Transportation Systems (ITS), alternative-fuel vehicles, and high-speed rail.

This project also sought to draw on research and experiences in fields beyond transportation planning. For years, the private sector has used performance-based planning principles to track performance in areas such as finance, human resources, research and development, marketing, and management. Nontransportation public sector organizations have also developed performance-based planning methods to manage and administer the delivery of public services. In order to avoid "reinventing the wheel," these private and public sector experiences were reviewed for their applicability to transportation planning.

Summary of Work Tasks

The focal point of the project work program was to develop a framework and approach to transportation planning that integrates a broad set of objectives into a planning process focused on performance and outcome. It was the aim of the research team to make the performance evaluation framework applicable to a variety of surface transportation modes, urban and rural settings, state and local contexts, and freight and passenger movements.

The approach of this research incorporated five distinct tasks:

1. Assembly of a thorough inventory of the basic elements which comprise the performance-based process, including example goals, objectives, and performance measures, plus the decision making and planning approaches driven by the measures. Examples were drawn from the public and private sectors and from transportation and nontransportation fields. Sources included published plans, research reports, interviews with practitioners, and focused case studies of current planning processes.

2. Completion of case studies were an important source of information for this research. A broad range of transportation situations was included in the case studies, from statewide multimodal transportation planning efforts to regional and facility-level implementation projects. We included multistate undertakings as well as public-private partnerships and turnkey projects.

3. Development of a typology of goals and objectives, with a clarification of the relationships between goals, objectives, and measurements of transportation system performance. The purpose of the typology in Phase 1 is to clarify how the selection of appropriate performance measures is a function of the particular goals and objectives, and how the data needs are, in turn, driven by the goals, objectives, and measures. The linkages between these elements of the process, and the feedback loops integrated into the process, are important defining features of a performance-based planning process.

4. Identification of analytical methods that are needed to put a new generation of performance measures into operation. These methods include data collection, storage, manipulation, and analysis procedures. A broad range of possible techniques, and potential desirable enhancements to methodology, are identified in order to accommodate a wide range of agency resources and needs.

5. The convening of several advisory meetings to present and review experiences with performance-based planning techniques and to solicit feedback on the research to date. Three advisory meetings with a regional focus were conducted in Cincinnati, OH; Portland, OR; and Atlanta, GA. The final advisory meeting had a national perspective and was held in Washington D.C.

Each of the first three tasks listed above resulted in a technical memorandum describing the research findings and conclusions. The results of the regional advisory meetings described in Task 5 were documented in a separate memorandum. The findings of Tasks 1-3 and the regional advisory meetings were integrated into a summary report.

KEY FINDINGS

Industry Reactions

The first phase of NCHRP Project 8-32(2) produced material of significant interest to the transportation planners, providers, and decision makers the research team consulted. While much work remains to be done before the necessary tools and skills are widely distributed and implemented, the researchers have identified numerous themes that have helped to clarify the actual needs of practitioners, the constraints under which practitioners operate, and the issues that need to be resolved in order for performance-based planning to take better hold. Following are several important findings from the research that should be taken into consideration in any further development and deployment of performance-based methodologies for application at the state, regional, and local levels.

1. Most important, integration of performance-based methods into the planning process remains a desirable and important objective. Experiences inside and outside of transportation agencies

indicate the need for improved practices and the value that can be gained in return. Today, there are more factors influencing transportation decisions than ever before, such as international trade and competition, deregulation and modal competition, environmental regulation, and the pluralistic nature of most transportation decision-making processes. The transportation system must serve an increasingly diverse customer base and many agencies have embarked on new or different missions emphasizing preservation, management, and user-orientation. Performance-based planning remains an important strategy in addressing these changing demands, independent of the presence or absence of ISTEA management systems.

2. States and metropolitan planning organizations (MPO) are looking for guidance rather than regulation. Flexibility of methodology and a great degree of self-determination rank high among their needs. More specifically, the impact of the current funding environment on agency capabilities cannot be overestimated. Agencies are under pressure to do more with fewer resources and they will not react positively to new mandates or structured planning regulations. This has clear implications for the way in which performance-based planning is framed and deployed. It is important to demonstrate the value of performance measurement to the planning and decision-making processes.

3. The methodology or tools developed from this research should not attempt to overrationalize the inherently political planning process. It is unlikely that a highly quantified methodology will replace a significant portion of the political process; rather, decision makers need to understand how it will enhance the process.

4. Although there are performance-based planning processes now underway, our research suggests that even today there is insufficient emphasis placed on system outcome or effectiveness. The historical preference toward measures of system output and efficiency has been carried forward because of limitations in performance-based data and analytical models. Agencies have had difficulty developing and applying measures that are descriptive of system performance in users' terms.

5. This lack of proper emphasis on system effectiveness is further illustrated by many agencies' experience with data-driven processes. In private industry as well as in the public transportation planning arena, practitioners have cautioned against letting the measures and data drive the process, which has often been the practice. Availability of certain types of data, whether due to data collection or forecasting techniques, has a tendency to determine what measures are developed, regardless of what set of measures may have been defined at the outset of the process. The result is that goals are inadvertently modified to fit the available measure and data, and the pursuit of measures becomes the overriding focus rather than the pursuit of goals. Most of our case studies and interviews revealed this continuing problem.

6. The selected performance measures need to be clearly related to and derived from broad societal goals, such as quality-of-life and economic health. Even in some of the more advanced, current applications of performance measurement, there is evidence that chosen measures are not good surrogates for what the transportation programs are supposed to accomplish. Instead, "the solution becomes the goal." For example, congestion management becomes the end goal rather than an improved quality-of-life or sustainable economic activity that congestion management is intended to provide. Again, the process too often focuses on achieving the measures rather than the underlying goals.

7. There are inherent differences between freight and passenger transportation, and between private-sector freight transportation activities and ones administered or provided by the public sector. One important difference is the time frame for making decisions, and the duration of commitment to a selected decision or course of action. The freight industry, and the private sector in general, makes decisions which are more responsive to changing market conditions. They may also change strategy more frequently than is desirable or feasible in the public sector. Therefore, performance measures aimed at freight transportation should distinguish between components of the system that are reasonably provided by the public sector and those that should remain the domain of private industry. Public agencies focus on providing access to public facilities and on ensuring the dependability of those facilities, while the private sector focuses on more dynamic investments which permit them to achieve their business objectives in light of changing market realities. The methodology should observe this division of function where it is valid.

8. To be useful on a variety of jurisdictional levels, a performance-based planning process should include both performance measures that are broad enough to guide system planning, and more specific evaluation criteria that improve the ability of agencies to select and prioritize specific projects or programs. The relationship between performance measures and evaluation criteria, and the linkage of both to broad goals should be clear.

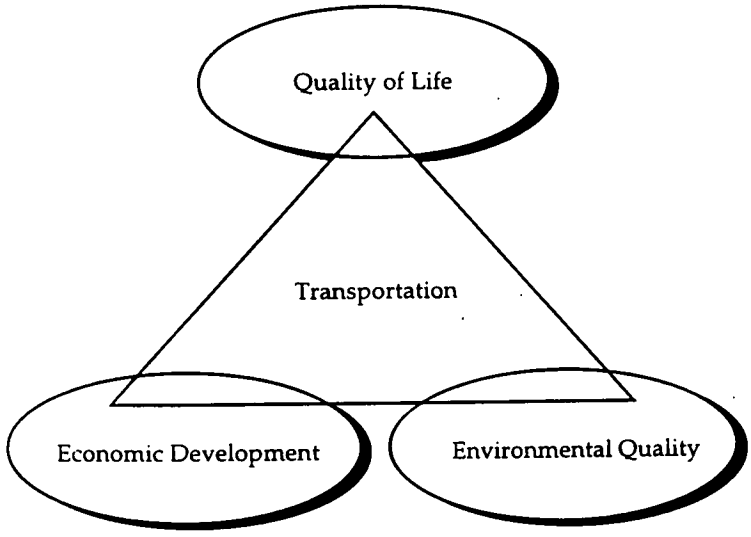
9. The different time horizons for long-range plans and more near-term project planning activities make it difficult to achieve this linkage. Decision makers, the public, and system planners all have different time horizons. This problem can be overcome partly by assuring that near-term evaluation criteria are directly related to longer-term measures and goals, and partly by using the process to periodically reevaluate and amend, as necessary, the long-range planning documents. Goals and performance measures need to be kept reasonably current with users' needs, and the planning process needs to be able to react more quickly to changing needs. Performance-based planning can be an important process for monitoring, evaluating, and modifying the implementation of long-range plans.

Framework for Performance-Based Planning

It is important to identify the relationship between goals and objectives and other key elements of the transportation planning process. A fundamental point of departure for performance-based planning is the definition of how transportation systems affect society. This perceived relationship between transportation systems and the activity of an urban area, for example, becomes a critical basis for measuring whether the transportation system is "performing" its intended functions.

Figure 1 suggests, in very simplified schematic form, the relationship between transportation and three of the major impacts often attributed to transportation systems. Transportation is one of the "empowering" factors that integrates economic development, environmental quality, and quality-of-life objectives. For example, the mobility provided by transportation systems gives individuals access to employment, social, and other opportunities that are the basic means by which to achieve an acceptable quality-of-life. This same mobility contributes to the overall economic development potential or competitiveness of the community. And finally, the provision of mobility can be accompanied by beneficial impacts to the natural environment, with a resulting secondary impact on quality-of-life and economic development potential as well. The transportation system, therefore, contributes in some way to each of these three fundamental objectives, and also causes some interaction among them.

The importance of the concept illustrated in Figure 1 is that if the underlying functional impact of the transportation system is related to achieving some other greater purpose (e.g., economic development), then the related measures of system performance should also reflect this broad purpose. The measures should not solely reflect the more specific transportation function (e.g., mobility) itself. Stated in the parlance of the public-sector nontransportation fields we reviewed, the performance measures should reflect the *outcome* of transportation system investments on these fundamental objectives, in addition to measuring the *output* of the system itself.



Transportation system performance has direct and indirect impacts on broader societal objectives and desires.

Figure 1. Transportation performance and societal objectives.

Relationship of Transportation System Impacts to Performance Measures

A second important concept illustrated in Figure 1 is performance measures should relate to the intersection of specific transportation functions and broader societal objectives. It is important to measure *what we can influence* through investments in transportation. This is suggested by the intersection portions of Figure 1. Again, using economic development as the example of a broad societal objective impacted by transportation, appropriate performance measures are those that describe the economy in ways that are clearly related to, and influenced by, the transportation system.

It follows that we must only measure that which can be reasonably attributed to some decision we have influenced through our methods. If the performance measures are drawn too broadly, we cannot say with any confidence that our chosen course of action is responsible for the change in the performance measure. For example, assume our broad goal is to enhance local economic activity and competitiveness through transportation investments. A more specific objective might then be to improve the access of employers to labor markets. Examples of poor measures include measures of productivity or employment in the local market, which are subject to influence by many external factors, some of them far more significant in their effect than transportation.

An example of a better performance measure would be the "number or percent of businesses with access to adequate labor supply within 30 min of the site" or "number of employable residents within 30 min of major employment center." (The precise definition of "adequate" or "major" is best left to the individual case.) Such a measure has several important attributes:

- It measures changes in the accessibility of labor that can be attributed, at least in part, to transportation system investments;
- It is a measure of an element (access to labor) that is clearly linked to the stated plan goals and objective; and
- It also is linked to one of the underlying impacts of transportation, i.e., economic development.

Such a measure has other desirable attributes, e.g., it can be measured with observed or synthesized data and it can be made mode neutral. However, the primary concern here is that it is tied to the broader strategic goals and objectives of the transportation system. This clear linkage is missing in the majority of current implementations of transportation system performance measurement.

Once this relationship between transportation system performance and societal needs is accepted, the relationship between goals and objectives and the rest of the elements of performance-based planning falls more easily into place. These elements include appropriate performance measures for the stated goals and objectives, data collection, and analytical methods. Some further explanation and definition of the different elements is helpful.

Goals and Objectives. Most transportation planning efforts begin with a definition of goals and objectives, which are typically recorded in the official planning documents of the appropriate jurisdiction (e.g., statewide, regional). This rational perspective on planning assumes that investment in transportation systems is aimed at achieving some ultimate purpose. Goals and objectives relate to system performance in that they reflect different perceptions of what the transportation system should be achieving. These goals and objectives are often developed through extensive public outreach efforts and thus incorporate a broad community perspective of what elements of system performance are truly important. Understanding different goals and objectives is critical to identifying the different types of performance measures that might be incorporated into the planning process. And, as the research has found, it is necessary to become more precise in the definitions of goals and objectives in order to make them more operational and less ambiguous.

Performance Measures. One of the major changes to transportation planning that has resulted from ISTEA is the requirement for planners to identify and to use performance measures in the transportation planning process. Beyond ISTEA, however, there is growing demand among elected officials, other decision makers, and planning professionals for greater accountability in the investment of public transportation funds. This sentiment is well documented in other governmental sectors as well as in private industry, and it is related to a growing emphasis on the quality of service provided to the users or "customers" of the transportation system. Identification of more goal-specific performance measures is an important precept of greater accountability.

Performance measures are, thus, critical elements of a performance-based planning process in that they determine what type of information is fed back into the investment and decision making processes, and ultimately relate to how "successful" system performance is defined. In terms of analysis, performance measures define the type of data that need to be collected, as well as the type of analytical tools that are necessary to translate data into information and thereby identify system deficiencies and opportunities.

Data. The performance measures selected as part of the planning process must be updated on a periodic basis, thereby pointing to some amount of continuous or periodic data collection. The high cost of ongoing data collection programs is a common and significant concern of many DOTs and MPOs today. Performance measures oriented toward system operations may continue to rely largely on data collection techniques that have been used for decades, such as traffic

counts, travel time studies, travel delay studies, and classification counts.

Broader performance measures are more likely to require spatially-allocated, socioeconomic information and other indicators of economic development or quality-of-life. Data on environmental impacts would be focused on the likely consequences of system operation on the natural or manmade environment. In some cases, the data could be surrogate measures (such as vehicle miles of travel) that act as indicators of impact. ITS technology is likely to play an important role in future data collection strategies that are required to support a broader variety of performance measures by allowing more regular observations to be made at lower ongoing cost.

Analytical Methods. The analytical methods required for each type of performance measure will clearly reflect the issues related to that measure and the type of data that are available for input. For example, system operation measures would be most affected by strategies aimed at improving the vehicle or person flow in key corridors. The analytical methods relevant to this type of strategy might, thus, include traffic flow simulation models, capacity and delay modeling packages, and network models. Measures that focus on the relationship between transportation system performance and other societal issues would require a broader range of analytical capability that relates concepts such as mobility and accessibility to specific outputs. Geographic information systems (GIS) could become an important basis for such analysis in that the spatial allocation of the "benefits" and "costs" of transportation investment will most likely be an important element of system effectiveness. Performance measures relating to externalities would be best analyzed using existing impact models, but the need to improve the accuracy of those models has been well documented.

Performance Measurement in the Planning Process

In one form or another, the elements discussed—goals and objectives, performance measures, data, and analytical methods—are all part of the existing planning process as it is carried out in most jurisdictions. Although the range of performance measures in most cases is quite narrow, they are, nonetheless, part of an existing process. What is new about the performance-based methodology is the *organization* of these elements, the *linkages* between elements in the process, and the presence of an ongoing monitoring process that provides *feedback* on the progress towards goals and objectives.

Figure 2 illustrates this point. Goals and objectives derived from the comprehensive planning process are related to the underlying impacts of transportation. These goals should, in turn, be reflected in appropriate performance measures. The measures then determine what data is required and what analytical methods are most appropriate. The data are supplied as input to the analytical methods, which enable the assessment of alternative strategies. The performance measures may be useful in identifying alternative strategies for evaluation by drawing attention to areas of unacceptable performance.

As shown in Figure 2, alternative strategies may be assessed with evaluation criteria that are distinct from the performance measures. This accommodates the fact that there can be many more consequences of actions than there are system performance measures. These evaluation criteria will likely cover a large variety of impacts that are of concern to local decision makers. The evaluation criteria should, however, be closely related to the defined system performance measures. By so doing, there is a stronger connection between project-level evaluation/selection and system performance measurement. This is one of the defining characteristics of performance-based planning as refined in this study. These evaluation criteria may be more specific to the alternatives evaluated in a given cycle (e.g., mode specific, greater emphasis on cost) to allow finer distinctions to be made between alternatives. They may be developed and organized into subsets for application to certain periodic procedures such as capital budgeting and Transportation Improvement Program development.

Cost-effective strategies then emerge from the process that will, over time, impact system operations. The system operations are monitored by the same performance measures that were initially used to identify and evaluate alternative strategies. This ongoing monitoring process will result in periodic adjustments to goals and objectives and to the performance measures themselves. Most important, it will give a periodic assessment of progress toward longer-term goals and objectives, and toward attainment of the underlying impacts of transportation, i.e., economic development, quality-of-life, and environmental quality.

Typology of Goals and Objectives

Our research identified examples of goals and objectives drawn from state and MPO transportation plans and management systems, as well as useful ideas and examples from other sectors and industries. This project, however, is focused on the evolutionary process of what the transportation planning process could look like given greater attention and discipline toward establishing clear linkages and feedback loops between the elements. As mentioned earlier, a cornerstone of a performance-based planning process is the definition of what is meant by system performance. This quickly leads to the question of, what are we ultimately trying to accomplish with purposeful changes to the transportation system?

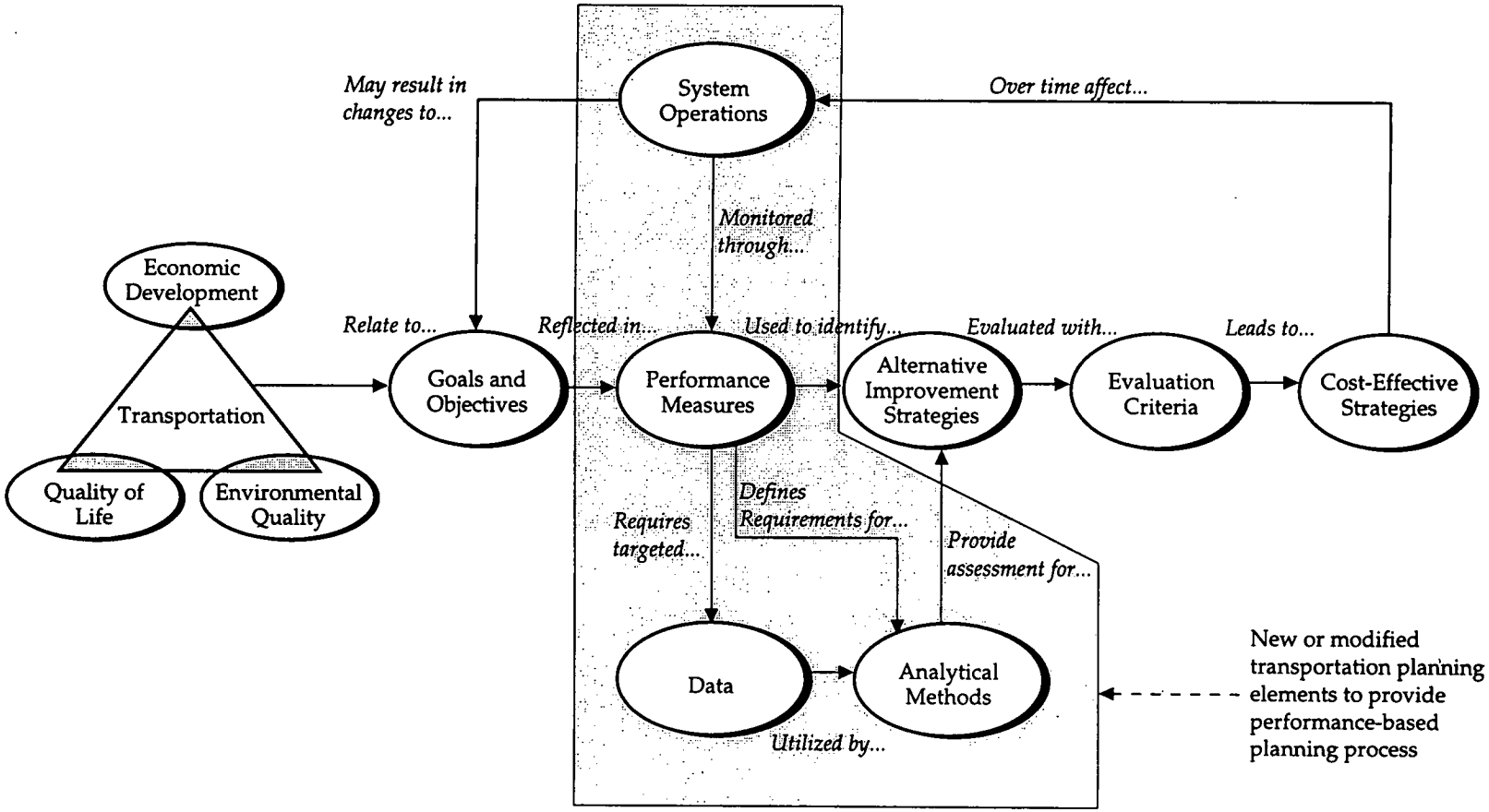


Figure 2. Elements of a performance-based planning process.

It seems likely that the major transportation issues faced by states and metropolitan areas will not change drastically over the next several years. [One change that *could* take place in a fairly short time period, with a potentially dramatic impact on transportation, is a rapid and large increase in petroleum prices.] The goals and objectives that relate to such things as enhanced economic development opportunities and reduced congestion will, therefore, continue to be found in most transportation plans. How we chose to define and monitor progress towards those goals, though, could change substantially. One fundamental shift suggested above is to go from an "owner" perspective of system performance to a "user" perspective. A good illustration of this is the long-standing, professional interest in finding ways to reduce congestion.

Identifying different approaches for measuring congestion has been an important topic in the transportation profession for many years. Most of the measures that were identified almost 40 years ago are still the major measures considered today. They measure the physical ability of the road system to handle vehicular demands, for example, the commonly used volume-to-capacity (V/C) ratio. However, congestion means different things to different groups. For the *operators* or *owners* of the road system, there are clear operations-based measures that relate performance to traffic volume and speed characteristics, as well as system-based measures that relate traffic levels usage to system capacities. For operations reporting, the desired measures would rely on the traditional data collected in every metropolitan area, e.g., traffic counts, screenline counts, toll counts, and boarding counts for transit. For systems monitoring, the measures would need to identify both changes in breadth and depth of congestion, where breadth could be defined as the percentage of traffic affected, and depth could be the total time (duration) of delay.

For the *users* of the road system, there are different measures that reflect actual trip patterns and trip characteristics and that allow comparison to desired trip characteristics. User-oriented monitoring and measurement would identify the differences between system measures and individual measures. For example, change in average travel times for specific origin-destination pairs, taken within the context of known average trip lengths and mode split data for a metropolitan area, permits assessment from the user's point of view.

The current most commonly used performance measures were derived from what, at first glance, appear to be diverse and unrelated groups. Managers have traditionally viewed performance in terms of cost effectiveness and efficiency. Civil engineers have placed emphasis on levels of service or facility-based performance monitoring. Systems engineers view queues and delay times as important measures of performance. Service providers have considered scheduling and routing issues as important determinants of transit system performance.

The performance measures which are derived from each school of thought carry with them owners' value judgments as to what the user may perceive as "performance." Frequently, no direct and concise connection could be defined between the user and the elements being monitored with the performance measure. The monitored elements became a surrogate for the user and have remained entrenched as current and accepted practice for the planning of transportation systems. The undesired result of this practice is the tendency to manage toward an optimization of performance measures that are not necessarily good representations of performance from the users' perspective.

Components of the Typology

A significant shift is required in the utilization of performance measurement in the planning process. There is a need to more directly incorporate accurate measures of the users' perception of system performance. This will require greater inclusion of measures of system effectiveness, rather than system efficiency alone. As stated in the lexicon of the service industries, more emphasis is required on the outcome of our transportation planning processes and investments, as opposed to the output of those processes and investments.

While measures of output and efficiency have an important role in the overall delivery of transportation services, the tendency has been to default to these measures, and to assume they reflect what the user wants out of the system. In fact, this research study and the researchers' discussions with practitioners, suggest that in most cases these measures have become surrogates for the customers' needs, and that all planning and programming activities tend toward optimization of the measures.

Although there are different ways of classifying goals and objectives for performance-based planning, a particularly useful approach for this project is shown in its most simple form in Table 1. The goals and objectives may be classified into three categories: efficiency, effectiveness, and externalities.

Goals and objectives that address system **efficiency** are about movement itself. The efficiency of the transportation system relates to those physical characteristics of system operation that correspond to vehicular, person, or commodity flows. This is the traditional perspective of system performance and it encompasses such topics as congestion relief, reduced costs of travel, and improved travel times. There are also many system **efficiency** goals in use that require descriptions of the output of transportation programs in measures such as the number of lane miles resurfaced and the number of revenue boardings. These can generally be labeled efficiency or output goals and objectives.

TABLE 1 Example typology of goals and objectives

	Goals and Objectives
Efficiency	Define movement itself; Focus is on system output
Effectiveness	Define purpose of movement; Focus is on outcome of actions
Externality	Define impact of system construction and operation; Focus is on external impact

In contrast, transportation system **effectiveness** is best defined in terms of what transportation provides for a community or the purpose of the effort and investment. As stated in the service industries, effectiveness is about what one is trying to deliver or what has been promised to the customer. Examples of stated goals are the transportation system should provide mobility for all citizens in the community, accessibility to economic activities, or transportation services should be provided and financed in an equitable way.

Externalities associated with the transportation system relate to the environmental and societal impacts of system construction and operation. Examples of externalities particularly germane to transportation include air quality, noise, dislocation of households and businesses, wetlands impacts, and water quality. There are also secondary or indirect impacts associated with the increased development that possibly occur as a result of enhanced accessibility.

Desirable Attributes of Typology Elements

This classification of different goals and objectives is helpful to understanding the different types of performance measures that might be incorporated into the planning process. The three categories of goals and objectives may be usefully carried through the typology to include performance measures, data, and analytical methods. Table 2 shows the desirable characteristics of all these typology elements. Such clarification helps the planning process by ensuring that the choice of goals and objectives directly influences the type of performance measures and evaluation criteria selected, the type of data that need to be collected, the analytical methods that convert this data into information, and, ultimately, the types of consequences that result from the implementation of strategies and actions.

Appropriate **efficiency** goals would define movement itself and focus on system output. A corresponding performance measure, therefore, would demonstrate features such as system capacity and utilization. Data must be collected which reflects these system or facility attributes, and the chosen analytical methods must be capable of assessing conditions with respect to capacity and utilization. (These are examples of a broad range of possible attributes.)

In the **effectiveness** category in Table 2, we see that different attributes should guide the identification and selection of goals, measures, data, and methods. To assess movement toward goals that take into account the purpose of actions, performance measures must demonstrate the outcome of actions in terms that system users themselves might adopt. This drives data needs as well, for it is then necessary to choose data that reflect the users' perception of outcome or service level, possibly at the trip level rather than the facility or system level. Analytical methods capable of assessing conditions at the trip level in user-familiar units or terms are then required. Stated another way, the methods must focus on the "intersection" of the user and the system, rather than on the system itself.

Finally, attributes of elements in the **externality** category suggest goals that focus on external impacts; measures must demonstrate the change in condition, or impact, resulting from action. In this category in particular, a variety of data are required that are capable of describing environmental or societal resources, and/or that describe features such as public health, welfare, and economics. Analytical methods must now be capable of assessing the intersection of, not only the system and the user, but also of the environment.

Examples of Appropriate Typology Elements

Having defined desirable attributes of each of the elements, it is possible to provide examples of goals and objectives, performance measures, data, and analytical methods for each case or category. These examples are not meant to be all-inclusive, but rather to demonstrate the range of possibilities within any given dimension of the typology.

TABLE 2 Desirable attributes of typology elements

	Goals and Objectives	Performance Measures	Data Collection and Monitoring	Analytical Methods
Efficiency	Define movement itself; Focus is on system output	Demonstrate system capacity and utilization	Reflect system or facility capacity and usage	Assess system and facility condition with respect to utilization and capacity
Effectiveness	Define purpose of movement; Focus is on outcome of actions	Demonstrate outcome in user-oriented measures	Reflect user impact, and perception, at the trip level	Assess intersection between system and user; assess condition from user point of view
Externality	Define impact of system construction and operation; Focus is on external impact	Demonstrate change in impact or condition resulting from actions	Reflect environmental or societal resources; public health, welfare and economics	Assess intersection of system, user, and environment; estimate contribution of transportation system to conditions

Table 3 lists examples that further clarify the distinction between efficiency, effectiveness, and externality. These examples also help to illustrate the important relationship across any horizontal row in the table—how identification of goals and objectives should dictate the remaining elements, rather than the reverse. As noted by participants during the regional advisory meetings, it is important to not let the measures, and the availability of certain types of data, drive the process. Goals and objectives should not be arbitrarily modified to fit the available measures.

PROPOSED RESEARCH PLAN FOR PHASE II

The following task list describes the plan for Phase II of this research, designated NCHRP Project 8-32(2)A:

1. **Publication of a research results digest** for Phase I of NCHRP Project 8-32(2). [This task is completed with the publication of this document.]

2. **Define the scope and content of the performance-based planning manual.** The research team will begin this task with a proposed outline of the manual. An initial outline is presented in Table 4. In the first weeks of the project, this outline will be refined and accompanied by explanatory text that will clarify our intention for each section. After comments and approval by the Phase II Project Panel, the outline will be finalized. The revised outline will serve as the blueprint for developing the manual.

3. **Select case study sites and conduct research.** Discussions with the Advisory Panel confirmed a desire to build the final products around a series of focused investigations into the current efforts of states, MPOs, and other institutions in the application of performance-based planning processes. Development of the performance-based planning manual will draw upon examples to provide real experience and context in illustrating how others have approached this problem, obstacles they have encountered, and how they overcame the obstacles. The findings of these case studies will constitute one separate chapter in the manual, and insights from the case studies will be distributed throughout the publication.

   The research team will also conduct approximately three to four workshops during the research to discuss our findings and progress with an appropriate cross section of transportation planning professionals. These will be organized as "breakout sessions" attached to regional or national conferences and meetings that will attract an appropriate audience. The purpose of these meetings is to satisfy the demand for more

information about this project in particular, and performance-based planning in general, as well as to solicit important feedback from the likely users of the research results.

4. **Prepare a performance measures library.** An important contribution to performance-based planning efforts would be made through the development of a performance measures library. This would be a reference compendium on alternative performance measures. Its purpose would be to offer practitioners who are either initiating a performance-based planning system or attempting to fine-tune an existing system, a concise look-up guide of potential measures.

   This guide would be developed primarily from materials and knowledge that are already available, but would be refined during the first several months of this research project. The plan is to develop a measures grouping under each of a series of relevant goals, objectives, or concerns.

5. **Prepare interim report.** An interim project report will be developed approximately 6 months into the project. The report will document the progress and accomplishments of the research to date. Comments from the Project Panel, and possibly from outside sources, will be requested. The composition of the interim report is expected to be as follows:

   - Summary of research objectives and work plan;
   - Summary of overall progress to date, problems encountered, key findings;
   - Summary of case study work;
   - Draft of performance measures library; and
   - Revised outline for performance-based planning manual.

TABLE 3 Example typology elements

	Goals and Objectives	Performance Measures	Data Collection and Monitoring	Analytical Methods
Efficiency	• Congestion reduction • Travel time • Cost of providing service	• V/C and related capacity measures • Speed and delay related measures	• Vehicle counts • Travel time and speed • Construction/ operating costs	• HCM Methods • Simulation models • Demand models
Effectiveness	• Mobility • Accessibility • Trip (or shipment) cost and reliability	• Percent population served by modes • Percent population within defined trip time • Cost per person or ton mile • Standard deviation of trip time	• Spatially-linked demographic data • Trip origins and destinations • Cost of trip inputs • Knowledge of incident frequency	• GIS linked network models • Statistical sampling and analysis methods
Externality	• Air quality maintenance • Sensitive habitat preservation • Safety of travel	• Vehicle emissions • Acres lost or preserved • System accidents or fatalities	• VMT as surrogate • Project site impact • Accident severity	• Emissions models linked to demand models • Risk analysis • Trend extrapolation

The primary purpose of this interim report will be to describe the project's progress sufficiently to obtain review and comment before proceeding with completion of the case studies and the manual.

The study team also suggests a joint briefing session involving the individual NCHRP 8-32 research projects in conjunction with delivery of the interim report. This would be a good opportunity for the research teams to inform one another of their progress and findings, the status of the individual products, and whether there are recommendations that should be more formally coordinated between research projects.

6. **Develop a performance-based planning manual.** The research team will develop a draft performance-based planning manual taking into account the Project Panel's comments on the interim report. Pending further discussion and panel feedback, the outline presented in Table 4 will be the basic guide for the manual. The case studies (Task 3) and the performance measures library (Task 4) are expected to be completed before production work is scheduled to begin.

   The draft manual will be submitted to the Project Panel for review and comment. Following review, a revised draft will be produced and efforts will be made to gain comment from a broader audience. This broader review will take the form of three to four workshops as described in Task 3.

   Dates for candidate meetings and conferences will be established and priorities will be set with consideration to the state of completion of the report and the people and interests represented at the conferences. A recommendation may be made for a workshop to be held in conjunction with one or more of these conferences prior to completion of the draft manual if it appears that the assembled experts offer a valuable opportunity to solicit timely information.

   Comments and reactions received from the panel and any workshops or breakout sessions will be incorporated into a final draft of the manual, which will be issued with the final project report.

7. **Prepare final project report.** A final project report will be prepared, documenting the overall process followed in conducting the research and completing the manual. This report will update the interim report and fill in remaining details of the project. The objectives of the final report are to formally document the work done in the research effort and to summarize any special problems that were encountered and solved, or any discoveries that were made. We propose to issue the performance-based planning manual separately from the final project report. While the final project report will include more background about the research project and case studies, the manual will be more user oriented, concise, and focused on the results.

Table 4 Preliminary outline for a performance-based planning manual

1. Meaning and Value of Performance-Based Planning

- What is performance-based planning?
- What are the reasons governments, agencies, and commercial businesses do it?
- What should you hope to gain by doing it?

2. Basic Principles of Performance-Based Planning

- Need for and characteristics of appropriate goals and objectives, linkage of long-range goals with short-range
- Societal and economic "outcomes" vs. transportation mode or program "outputs";
- Multimodal vs. single mode orientation, market segments;
- Customer vs. supplier perspective; and
- Use of performance-based planning process to highlight tradeoffs, aid decision making, support resource

3. A Framework for Performance-Based Planning

Present a framework that provides users with a flexible structure for designing and developing appropriate performance-based planning systems, components of which include

- Passenger vs. freight;
- Public vs. private;
- Trip purpose or commodity;
- Local, regional, long-haul distance; and
- Supplier vs. user perspective.

4. Guidelines for Performance Measures Development

- Characteristics of good measures:
  - — "Indicator" measures vs. "performance" measures
  - — "Outcome" vs. "output" measures
  - — Defining causality
  - — "Multimodal" vs. "single mode" measures
  - — "Supplier" vs. "user" measures
- Important considerations when developing a system of performance measures:
  - — Prioritize importance of measuring primary goal and objective outcomes
  - — Do not be driven or constrained by available data
  - — Accept "evolutionary approach" in developing "ideal" measures over time
  - — Use surrogate measures to address data constraints in the short run
  - — Do not avoid a goal or concern simply because it is difficult to measure
  - — Importance of establishing a baseline
  - — Use of benchmarks and standards
  - — Importance of establishing causality

- Classes of measures and guide to use of performance measures library:
  - — Access and mobility
  - — Effectiveness and efficiency
  - — Outcomes and externalities
  - — Condition and performance

5. Data Resources

- Sources of data to develop useful measures,
- How to make the maximum use of data resources,
- Techniques for assembling consistent data,
- Examples of how to tie in other data to ISTEA management system data,
- Sources for freight/private carrier data and measures,
- Obtaining customer/user satisfaction data,
- Opportunities for using emerging technology to supply data, and
- Techniques for developing data to support multimodal measures.

6. Case Studies

A review, comparison, exposition, and evaluation of the experience of various sites that have implemented or experimented with performance-based planning systems.

- State, MPO, or private efforts;
- Comprehensive systems or systems specific to mode or market; and
- Successes and failures, and lessons learned.

Appendix: Performance Measures Library

This section would contain a system of tables offering potential performance measures for each of the defined concerns and measurement themes. It would include optimal measures which assume few data constraints, as well as surrogate measures which recognize current data constraints. It might also include optional measures within a defined theme for different levels of application, e.g., safety measurement and monitoring at the facility, corridor, or system level. Measures would be indexed according to useful parameters such as the level of detail required (i.e., level or scale of application), data availability, or probable users of the measure. The indexing system would facilitate relatively easy retrieval of example measures to be applied to a given need or situation.

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