

MEASURING LEVEL OF SERVICE AND PERFORMANCE IN PUBLIC TRANSPORTATION

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PERFORMANCE IN PUBLIC TRANSPORTATION**

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EXECUTIVE SUMMARY

Public transportation evaluation, like the evaluation of so many other public programs and services, potentially can involve hundreds of different evaluation criteria, depending on the purpose and perspective taken in the evaluation process. In the 1990s several new transportation-related legislative mandates (e.g., Intermodal Surface Transportation Efficiency Act, Americans with Disabilities Act of 1990, Commute Trip Reduction Law, clean air acts, Growth Management Act of 1992) initiated a new round of transportation planning activities in Washington State and across the U.S. These mandates reflect many different underlying assumptions about the role and purpose of public transportation services, as well as the types of evaluation foci and outcomes generally considered important. Although each of the mandates directs planners, politicians, and communities to inventory current conditions, to plan for some desired future and, most importantly, to develop criteria by which to evaluate plan attainment, there has been a lack of understanding of how these mandates relate to each other and how relevant evaluation criteria should be defined and measured. That shortcoming led to the request for this project.

The evolution of this project and the wide range of research activities undertaken transcend many of the specific issues that motivated the project's inception. At the most general level the project was focused on questions relating to evaluation of transit systems, including the following:

- What are the political mandates that define the role of public transportation? In what ways are they consistent or inconsistent? How should their attainment be measured?
- What are the underlying constructs and logic of different evaluation criteria? How might we classify and categorize these criteria to more clearly understand what they measure?

- How do the potential perspectives taken in evaluation processes differ? Do these perspectives make a difference in terms of the definitions derived for evaluation and the conclusions reached in evaluation processes?
- How can the adoption of various evaluation criteria definitions, and overall processes of evaluation, be better understood by all of the parties, but especially state agencies, that potentially have an interest in them?

As the project progressed, state interests changed in directions not anticipated at the outset. However, the broad questions noted above provided a continuity of purpose throughout the project, even though some of the specific tasks had changed. Our primary intent is that the results of this effort be used in the development of policy and program evaluation frameworks related to public transportation.

The research, presented in a series of ten working papers and described in this report, provides a detailed framework for classifying and interpreting various approaches to the development of public transportation evaluation criteria, including those referred to as level-of-service (LOS) criteria. Furthermore, it applies this framework to a number of prototypical planning situations, evaluation tasks, and statistical analyses to reveal how the performance of public transportation activities is valued differently along several potential dimensions of evaluation. The research reveals how different parties and government agencies often approach evaluation of specific public transportation activities from singular, and constrained, points of view. Such approaches can lead to development of potentially misleading evaluation criteria definitions (as seen in the case of Growth Management LOS criteria developed at the community level in Washington State), to a limited critique of major public transportation investment programs (as seen in the case of the Commuter Rail proposal packaged as part of the Regional Transit Plan of 1995 that failed at the polls), and to contentious equity fights between community groups and transit providers (as seen in the case of the West End Bus Project in Jefferson County, Washington).

The primary goal of this research effort has been to provide a series of working papers that clarify the evaluation process, while contributing to the Washington State planning process. Therefore, the results are better understood in terms of the products produced rather than as a series of conclusions. This material is intended to serve as a reference for ongoing and future public transportation planning efforts, in addition to the contribution it has already made to the Washington State Public Transportation Plan development. The major products of the project include the following:

- A **comprehensive conceptual framework** that clarifies the relationship between the components of the entire public transportation planning process.
- A **computer-based matrix that identifies key requirements of public transportation** in six major pieces of federal and state legislation and that links those requirements to the 22 Washington State Public Transportation Goals and the 46 subgoals identified in the 1991 State Transportation Policy Plan.
- An **analysis of state and local planning roles** and alternative models of assessment for public transportation evaluation.
- A thorough **review of performance measures** organized around the conceptual framework in order to demonstrate accurately the potential contribution of each measure to the overall evaluation process.
- A detailed statistical analysis of the relationship between performance measures and the influence of context on the performance levels of transit systems.
- A comprehensive **review of alternative definitions of level of service** organized according to the conceptual framework.
- **Three case studies investigating the use of level of service concepts** that incorporate different roles for state involvement in the planning process.
- A **prototype Index of Accessibility** that can be used to assess the level of local achievement for state-defined minimum standards of accessibility.

To varying degrees, these materials, and the process that produced them, have contributed directly to the development of the Washington State Public Transportation

Plan. However, their more lasting role is to serve as resources for both state and local authorities wrestling with complex problems related to defining system goals, choosing and interpreting performance measures, and setting and evaluating level of service standards. There is no single or simple formula that emerges from this work. Rather, we have demonstrated the importance of conceptual clarity in dealing with what is inevitably a complicated process of public transportation evaluation. We have offered a robust framework for organizing the elements of this process and have provided a wealth of statistical material and case studies that can be used to improve the public transportation process according to the needs and political realities of the local level and the evolving interests and political realities at the state level.

INTRODUCTION

PROBLEM THAT LEAD TO STUDY

In the early 1990s interest in the subject of transportation performance analysis and evaluation intensified because of the passage of a number of new legislative initiatives at the state and federal levels. The planning requirements associated with these initiatives instilled a new sense of urgency in the transportation evaluation problem. The research described in this report is one of several efforts undertaken within the State of Washington and across the country that are aimed at providing new insights into performance evaluation tasks. Unlike many of the other efforts undertaken, this project addressed the problem primarily from the perspective of public transportation, rather than from an automobile or highway point of view.

The research described in this report was motivated by four inter-related issues. First, the research resulted from the need to define and interpret the transportation evaluation process for public transportation in the context of several new legislative initiatives (e.g., Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), Clean Air Act, Americans with Disabilities Act of 1990 (ADA), and Washington State Growth Management). These initiatives have been interpreted by many in the transportation planning community as suggesting a redefined role and level of expectation for public transportation. This research project was thus conceived, in part, to synthesize a new understanding of the expectations for public transportation that result from an integrated view of the various mandates and, where possible, to contribute to the Washington State Department of Transportation's (WSDOT) development of several planning documents required by the new legislation. Most notably, this research effort paralleled WSDOT's development of a State Public Transportation Plan that is a sub-element of the Washington State Multi-Modal Transportation Plan required by ISTEA.

Second, and closely related to the first issue, this research was motivated by the desire of transportation planners to develop a better understanding about the possible integration of public transportation evaluation with other modes, namely automobile infrastructure. This practical integration is implied in several planning activities within ISTEA (e.g., Congestion and Intermodal Management System Requirements), the Clean Air Act (e.g., evaluation of transportation control measures), and Growth Management (e.g., defining, analyzing, and enforcing level of service (LOS) requirements within comprehensive plans).

Third, this project sought to re-articulate the issues associated with the transportation evaluation processes primarily from a state perspective. WSDOT was interested in the clarification of state responsibility in the evaluation of public transportation activities and the development of evaluation measures and tools to support the responsibilities identified. In effect, much of WSDOT's interest in this research was centered on developing planning documents, policies, and strategies that clarify the state-level interest in public transportation evaluation; how this evaluation interest could be implemented; and, finally, how this evaluation interest relates to the concerns of both local providers and community oversight groups.

Fourth, this research sought to contribute to transit research at the national level by developing new statistical profiles of public transportation performance. Specifically, the focus related to this fourth goal was the analysis of multiple measures of performance and their inter-relationships. At issue in this part of the research was how the multiple measures of performance correlate with each other and how the interpretation of these measures is influenced by geographic and jurisdictional context.

OBJECTIVES AND SCOPE OF RESEARCH

The specific research objectives associated with this project can be grouped into two categories. The first group generally relates to research activities that were designed

to provide **conceptual clarification** to the complex intersecting legislative mandates that guide public transportation services and to the development of evaluation criteria for interpreting public transportation's success in meeting these mandates. The specific objectives of this research include the following:

- the development of a framework to categorize the inter-relationships among the concepts found in the new legislative environment that define expectations of public transportation at the time of the research
- the development of a framework to organize and interpret a wide range of potential performance and level-of-service criteria that are potentially useful in assessing the success of public transportation in meeting its legislative expectations and mandates.

The second group of objectives generally relate to research activities that were designed to develop and enhance appreciation for the **application of specific performance evaluation criteria**. The research objectives in this category include the following:

- exploration of specific applications of evaluation processes and criteria for different legislative mandates
- exploration of the use of evaluation criteria specifically associated with state-level planning goals
- exploration of the relationships between typical public transportation performance measures and geographic context variables

Each of these objectives resulted in one or more activities and working papers that are more fully described in the research findings section of this report and in the appendices. The two major categories used to organize the description of objectives above are also used in organizing the contents of the Research Approach and Findings sections of the report. This framework should facilitate selective reading of the report.

REVIEW OF OTHER WORK

The broad scope of this project, its timing, and its association with a state-level planning process that ran parallel to this research required a multi-faceted review of both previous research and other roughly concurrent local and national efforts working on the transportation evaluation problem. Because of this complexity it is impossible to review all of the work on this topic that was considered by the research team. Rather, this section highlights the major influences that structured our entry into the problem. This approach is perhaps best described in terms of several themes that emerged both from the existing literature on performance assessment and from the planning processes we observed early in the research.

A MULTITUDE OF MEASURES

Our review of transportation literature revealed literally hundreds of measures (and dozens of studies) that have been used to evaluate public transportation delivery and performance. One of our early observations about the various uses and definitions of these measures was that certain concepts such as "effectiveness" and "efficiency" were often used to group these measures, but they were generally not consistently defined. An example of this definition problem is seen in the application of the farebox recovery rate performance measure. This commonly cited measure, typically defined as operating cost divided by operating revenue, was classified as "efficiency," "economy," "cost effectiveness," and "financial" in various reports in the transportation literature (Tennyson 1993; Kelley and Rutherford 1983; Carter *et al.* 1990; Glauthier and Feren 1977; Guiliano 1981).

Similarly, we found that research articles and reports from national meetings (e.g., Ewing 1993), other states (e.g., California Statewide CMP/AQ Comprehensive Study 1994), and other more local planning activities (e.g., Puget Sound Regional Council Ad

Hoc LOS Committee 1992-93) used a wide range of criteria and definitions for the concept of “level-of-service” (LOS). This review of ongoing work aimed at redefining LOS for both automobiles and other modes strongly suggests that any attempts to understand the implications of LOS for public transportation evaluation must begin with an overview of its traditional application to roadways. The attempts to re-articulate the definition and application of LOS, with this traditional focus of evaluation on the ease of automobile movement, was best exemplified in the work of Ewing (1993).

Ewing (1993) suggested four possible paradigms for "transportation service standards"—in which public transportation, among other factors, is embedded—as conceptual alternatives to the traditional use of auto travel "speed." These concepts include mobility, accessibility, livability, and sustainability.

"Whereas levels of service relate to facilities, "mobility" generally pertains to *populations*, "accessibility" to *land uses*, "livability" to *environments*, and "sustainability" to *communities*." (Ewing 1993, p.7)

Ewing also provided a “menu” of potential performance measures, or evaluation criteria, as an overview of the possibilities for assessing transportation system performance within these alternative foci for evaluation. His list included a mix of measures such as areawide LOS, areawide congestion indices, ridesharing/TDM measures, multimodal mobility measures, accessibility measures, VMT and VHT, and travel quality indicators. Unfortunately, Ewing did not systematically consider the implications of these possibilities in explicit juxtaposition to the paradigms identified above, and his "bottom line" left the problem of LOS definition unresolved. Thus Ewing's categories of evaluation measures did not provide an adequate understanding of what the selection and use of these various alternative measures mean as part of an evaluation process. Furthermore, despite the desire to develop a multi-modal LOS definition framework, the approach to performance measurement and LOS offered by Ewing clearly originated from a traditional automobile perspective of transportation systems and only in a very limited sense dealt with the implications of public

transportation. In contrast, our research was primarily concerned with clarifying the intent and meaning of "LOS" definitions and transportation evaluation from the perspective of public transportation.

PERSPECTIVES AND PHILOSOPHIES OF EVALUATION

A second theme that emerged from our review of the literature was the recurrent emphasis by previous researchers on the importance of understanding how different purposes, perspectives, and basic philosophies towards evaluation inherently structure both the criteria selected and their application. A primary example of this phenomenon is seen in the distinction between local agency application of performance criteria and the use of the same and different criteria by those outside the agency with some interest in evaluation. For example, a number of researchers noted the differences in opinion about how state evaluation of public transportation should be implemented (Fielding 1992; Carter *et al.* 1990). The basic tension in this area is between those who espouse the application of strict performance criteria at the state level (see Levinson and Sanders 1993 and Carter *et al.* 1990) and those who believe that the context of application should be considered within some general guidelines for performance (Guiliano 1981).

This basic tension related to the role and use of performance criteria and standards once again suggests the need for conceptual clarification as a starting point for interpreting how the use of performance information might be better understood from multiple perspectives, particularly in light of the new legislative demands on public transportation. This part of the literature review also pointed to the potential value of statistical profiles of performance that incorporate aspects of geographic context, and although this type of approach is not entirely new, the purpose of its further investigation in this project was to build on previous (Fielding 1985; Kelley and Rutherford 1983) and concurrent (Hartgen and Mather 1994) statistical work on transit performance indicators.

MANDATES, GOALS, OBJECTIVES AND OUTCOMES IN EVALUATION?

In addition to the issues discussed above, our review of literature on the performance evaluation topic generally revealed a lack of emphasis on defining mandates, goals, and objectives for public transportation activities and the outcomes achieved as part of the evaluation process. In other words, our entry into this research was largely shaped by the observation that previous research had generally provided only cursory treatment of the links between mandates of public transportation provision and other aspects of evaluation, particularly the results and outcomes of these activities. Our interpretation of past research on the topic (e.g., Kelley and Rutherford 1983; Fielding 1985) suggested that the emphasis in previous studies primarily was from a narrower transit agency focus in which the goals, objectives, and community outcomes were often only superficially treated. These issues are more fully described in the Research Approach section.

RESEARCH APPROACH

The research approach developed to address the void in current understanding related to performance evaluation was structured around two levels of analysis, as noted in the introduction. The first level of analysis was designed to provide **conceptual clarification** related to the legislative environment that provides the context for public transportation and for the definition of terms associated with the use of specific evaluation indicators. The specific research activities undertaken in support of these tasks are discussed in the following subsection.

The research approach associated with the second part of the project involved the **application of the evaluation criteria within the conceptual framework** developed in the first phase to case studies and a national data set. Whereas the first phase of the research project was primarily qualitative in orientation, the research activities undertaken in phase two included both quantitative and qualitative dimensions. This second phase of the research project concentrated on an examination of several case studies that linked a representative evaluation process typically required by current legislative mandates with actual measures and data. The research in this phase also involved a quantitative exploration of the linkages among certain performance variables and different measures of geographic context.

CONCEPTUAL CLARIFICATION

This section describes the specific approaches taken to provide conceptual clarification for transportation evaluation contexts, processes and terms. The first part describes the approach taken in the earliest stages of the project to provide clarification of the various legislative mandates that define the expectations and regulations surrounding public transportation. The second part discusses the approach taken in developing a

framework through which to interpret the definition and application of specific evaluation terms.

Legislative Mandates and State Public Transportation Policy

The policies, legislation, and regulations that provided the context for this research stemmed from several important state and federal initiatives. These initiatives included the Clean Air Act Amendments of 1990 (CAAA), the Americans with Disabilities Act of 1990 (ADA), and the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) at the federal level; and the Growth Management Act of 1992 (GMA), the Commute Trip Reduction Law (CTR), and the Washington Clean Air Act (Wa. CAA) in Washington State.

This part of the research examined these six major federal and state policy initiatives in juxtaposition with the 22 Washington State Public Transportation Goals identified in the 1991 Washington State Transportation Policy Plan. The 22 goals fall under six broad categories: Personal Mobility, Working Together, Finance, Economic Opportunity, Environmental Protection and Energy Conservation, and Protecting Our Investments. The 22 goals were themselves divided into more narrow "subgoals" implicit in each. For example, Personal Mobility was defined as follows: "An appropriate level of safe, reliable, and convenient public transportation should be available to people regardless of their sex, age, disability, race, religion or ethnic background." This goal can be parsed into four subgoals, i.e., "Safe," "Reliable," "Convenient," and "Equitable."

A total of 46 such subgoals were identified and connected to each of the six policy initiatives, revealing ways in which the goals are mandated or supported by law, or made more specific through legislation and regulations. The result of this cross-tabulation was an information matrix that illustrated the connections between the various legislation and the transportation goals as they existed at this phase of the research. This matrix was constructed within Microsoft Excel for Windows. A diskette containing the matrix and a guide for its use was distributed with a separate working paper (see Hodge *et al.* 1994a).

Framework for Categorizing and Interpreting Performance and LOS Evaluation Criteria

A major focus of this research was to situate a discussion of public transportation evaluation criteria within an encompassing conceptual framework in order to lend conceptual clarity to (1) the factors that different criteria actually measure, and (2) the implications resulting from those measurements. The conceptual framework developed to facilitate these activities is outlined in Figure 1. This framework makes it possible to more fully comprehend what evaluation criteria actually do, and do not, address with regard to public transportation provision. It also serves the important role of providing a framework for interpreting how and where different stakeholders in some evaluation contexts place emphasis in the complex task of evaluating the provision and performance of transportation services.

In the process of public transportation provision and evaluation shown in Figure 1, public transportation providers are faced with the challenge of meeting certain **objectives**, which themselves are derived from more general **goals** for public transportation. Public transportation goals are embedded within a societal context and provide a general sense of direction and intent for public transportation. Given recent legislation and changes in the institutional environment of public transportation, goals are changing, which makes evaluation of public transportation even more difficult (Fielding 1992). The goals that motivate provision of public transportation are represented by a series of objectives, which more specifically address **how** the goals are to be achieved. Together, goals and objectives provide the policy context within which public transportation provision and evaluation takes place (Kelley and Rutherford 1983).

The third stage of the framework for public transportation provision and evaluation focuses on inputs. **Inputs** are allocated to support objectives and include both financial and resource inputs, as well as infrastructure inputs. The inputs are directed to provide a combination of **activities**, which must be selected from a variety of options

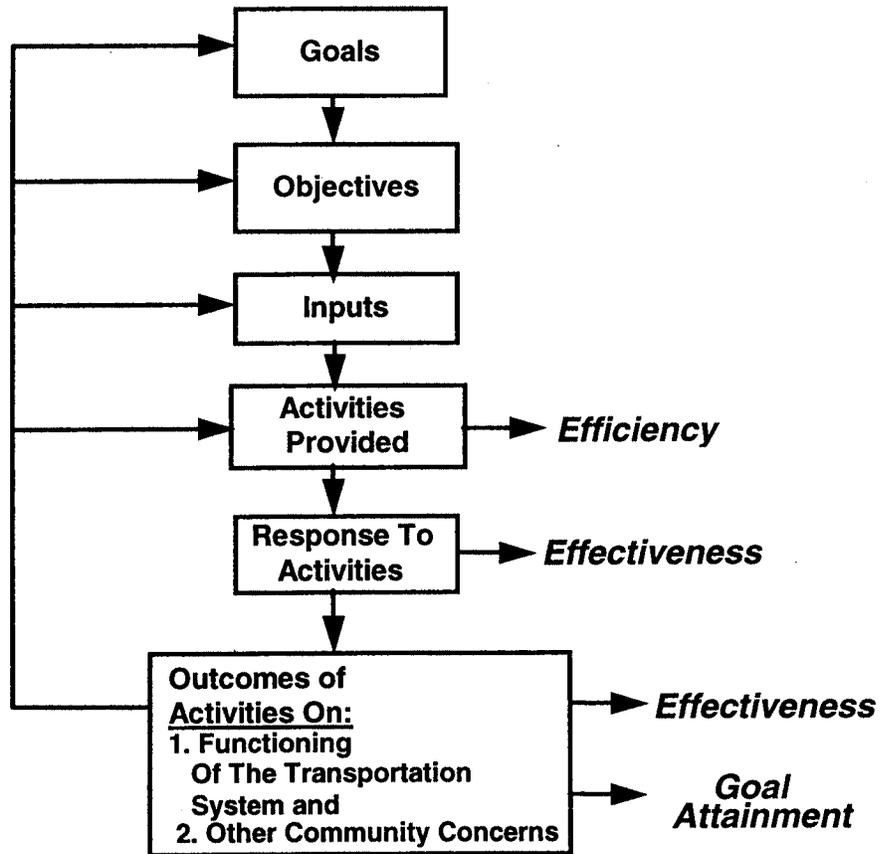


Figure 1. Basic Elements of Transportation Provision and Evaluation

including, among others, fixed-route service, demand-response service, high occupancy vehicle (HOV) lanes, pricing policies, bicycle lanes, and public education and awareness campaigns. The activities are intended to generate a **response**, or level of use, by the public. Providers hope that the response to these activities has some positive **outcomes** related to the overall functioning of the transportation system (e.g., achievement of earlier stated objectives) and to other community concerns involving transportation. The process of evaluation does not end here, however. The outcomes of public transportation provision and utilization should then be compared with the original goals to determine whether these goals have been attained via different types and levels of input and activities, as well as whether the outcomes have been effective. An analysis of the **goal attainment** resulting from these outcomes and the **outcome effectiveness** should allow providers and the public to assess how well the goals were achieved, to what degree, and at what cost.

The significance of understanding the process of public transportation provision and evaluation from the perspective of this framework can be seen by comparing the framework with other work that has been influential in the public transportation community. In particular, the work of Fielding (1985) and the work of Kelley and Rutherford (1983) has attempted to relate performance measures to the provision of public transportation. But, as shown in Table 1, in previous work the performance review ended with service consumption, whereas this research effort makes more explicit the connections between the transportation system and community outcomes. For example, where other analyses of performance assessment saw service consumption as the final phase of the process, the model developed here goes further by explicitly connecting the actual outcomes and impacts induced by service provision and consumption with the goals driving the process. In addition, whereas much of the emphasis in previous work

Table 1. Comparison of UW framework with past approaches to public transportation provision and evaluation

University of Washington Elements of Public Transportation Provision and Evaluation	Fielding's (1985) Dimensions of Transit Performance	Kelley and Rutherford (1983) Transit System Performance Methodology For Washington State (Data Elements)
Goals		Goals
Objectives		Objectives
Inputs (Financial & Resources)	Inputs (Used To Produce Service)	Service Inputs Public Assistance
Activities Provided: Related Policies Characteristics Quantity Quality	Outputs (Service Produced)	Service Outputs Service Area Service Design/Distribution
Response To Activities: Absolute (Passengers) Relative (Mode-Split)	Consumption (Passengers)	Service Consumption (Passengers)
Outcomes on the Transportation System		
Other Community Outcomes		

focused primarily on traditional transit system performance (i.e., fixed-route services), the approach in this research assumes a broad definition of public transportation activities and policies.

The framework developed in this research incorporates and defines the two most cited evaluation criteria categories: effectiveness and efficiency. Although it is defined in various ways in the transportation literature, *efficiency* generally refers to *the use of some input to provide some activity*, whereas *effectiveness* generally measures *a response or an outcome per input or activity provided*. While the term "efficiency" can have much broader meanings, in public transportation it has generally been used to refer to the use of inputs (dollars or other resources) to provide an activity, which is how the term is also

used in this paper. Additionally, in this work, both efficiency and effectiveness are defined as **derived** measures; that is, they are ratios that combine two separate measurements (input/activity or response/input). As noted in the introduction, the use and implications of efficiency and effectiveness in public transportation provision and evaluation are understood and often applied differently across the field of public transportation.

In Kelly and Rutherford (1983), effectiveness measured the extent to which an agency met goals, and efficiency measured the use of resources. While efficiency in the private sector is often a useful evaluation criterion, the provision of public goods and services, such as public transportation, is more complex and requires other criteria, particularly since institutional conditions (constraints) surrounding public transportation in some contexts will not allow either efficiency or effectiveness to be maximized. Our interpretation of the efficiency concept suggests that its definition should incorporate not only financial efficiency, but also efficiency related to the use of resources and the provision of activities. The distinctions between the different uses of efficiency as they relate to the framework are further elaborated in the findings sections of this report. Similarly, the definition and use of the concept of effectiveness should incorporate dimensions of resource and activity effectiveness in addition to financial or cost effectiveness.

The use of this framework shows how the evaluation process typically emphasizes different dimensions that generate different conclusions. This framework was thus a central organizing device used throughout the research. It was used first in this project to organize and interpret the definitions of the various performance indicators found in the transportation literature. This included a cross-tabulation of Section 15 indicators with the framework as reported in Hodge *et al.* (1994a).

The framework was also used to interpret various definitions of Level of Service (LOS). Our interpretation, as reported in the findings section of this report, showed how

various past and evolving definitions for LOS criteria actually span across most of the elements in the framework, depending upon the context of evaluation (Hodge *et al.* 1994b).

The framework was also a central part of the various case studies carried out in this research (Hodge and Orrell 1994). The application of the framework to this diverse set of evaluation contexts provided a common perspective from which to interpret the intended purposes of evaluation measures to support some planning goal.

EXPLORATION OF EVALUATION CRITERIA APPLICATIONS

Case Studies

Four case studies were undertaken to explore the use of evaluation criteria for prototypical planning situations. The first case study explored the evaluation processes involved in the development of a new rural public transportation service in the far-western reaches of the Olympic Peninsula. This example provides insight for evaluation contexts in which the focus is the state's interest in **basic regional accessibility in rural areas**. The second case study examined the development of local LOS definitions and standards under growth management planning in three King County cities: Bothell, Kent, and Seattle. This case explored the various proposed uses of evaluation criteria to implement the intents of growth management, particularly as related to the concept of **concurrency**. The third example examined a multi-modal transportation corridor in the Puget Sound Region (Everett-to-Seattle), where the concerns of **regional mobility, air quality, and congestion** dominate the evaluation process. These three case studies provide prototypical examples of the use of evaluation criteria associated with several major legislative initiatives in public transportation (Hodge and Orrell 1994). They were designed in part to demonstrate how a wide range of criteria are typically involved in performance assessment within the overall conceptual framework for evaluation outlined in Figure 1.

The fourth case study involved an approach to define Washington State's interest in basic accessibility for its citizens (Hodge and Orrell 1995), an important goal identified in WSDOT's State Public Transportation Plan. This study applied readily available Geographic Information System (GIS) technology and data in a prototype application designed to show how the state might define and evaluate minimum levels of accessibility using several different evaluation criteria.

Performance Measure Profiles and the Relationship of Context to Performance

This part of the project used a number of multivariate statistical techniques to generate statistical profiles of performance measures and to analyze the relationships between the measures, as well as their relationship to context. The selection of performance measures from Section 15 data is explained in Hodge *et al.* (1994a); the explanation of the choice and computation of context variables is explained in Hodge and Devine (1995a); and the methodology and results are discussed in Hodge and Devine (1995b). The analysis was based on 318 transit systems from throughout the U.S. that had a minimum of five motorbuses in their fleet. Factor analysis was used to reduce the original list of performance variables to a smaller list of factors. Transit systems were then grouped according to the similarity in their scores across the factors. Finally, differences in context variables across the groups were analyzed using analysis of variance and eta-squared. These steps were repeated for context variables. The original list of context variables was reduced through factor analysis; systems (through their county identification) were grouped according to similarity in their context factor score; and differences in performance scores were analyzed for the clusters. The final parts of the analysis used multiple regression to estimate the cumulative effect of context on performance measures.

FINDINGS/DISCUSSION

CONCEPTUAL CLARIFICATION

Goals and Objectives Cross-Reference Framework

A portion of the information matrix developed to clarify the relationships between WSDOT's 22 public transportation goals and 46 subgoals, and the six public policy initiatives that define the legislative environment at the time of this research is presented in Figure 2. Goals and subgoals are listed across the top, and major policy initiatives appear down the leftmost column. Reading across any row in the matrix reveals the applicability of that particular law to the specific goals identified in Washington State.

Microsoft Excel - MATRIX.XLS										
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	A	B	C	D	E	F	G	H	I	J
1	Goals:	Personal Mobility								
2										
3						Public transportation should enhance the quality of life of all persons, particularly those with special needs		There should be some form of public transportation in all communities of the state.		Public transportation services and facilities should conform to the Americans with Disabilities Act
4						for whom the lack of transportation would otherwise be a barrier to services and social interaction.				
5		An appropriate level of safe, reliable, and convenient public transportation should be available to people regardless of their sex, age, disability, race, religion or ethnic background.								
6	Public Policy Initiatives									
7										
8	or Regulations	Safe	Reliable	Convenient	Equitable	Quality of Life	Special needs	In all state's communities	ADA Services	ADA Facilities
9										
10	Federal									
11	Clean Air Act 1990	* Exempt from reactions		* Congestion * Traffic flow * HOVTCM * Mass transit * Exemptions		* Protect public health from air pollution				
12	ADA	* Safety of facilities	* Recreations * Times available	* Paratransit * Times * Area * Prearranged * Attendant	* Paratransit availability comparable * Fare		* Paratransit available for disabled		* Paratransit requirements	* Accessibility of stations and vehicles
13	ISTEA	* Flexible funding * Matching ratio			* Elderly, disabled, poor, rural/urban * TIPs consider	* NITS emphasis * TIPs consider	* Elderly, disabled, poor	* Funds split by population * \$5000 must receive funds	* Full ADA compliance before transfer of funds	* Full ADA compliance before transfer of funds
14	State									
15	GMA									* County & city plans * Intergovernmental coordination
MATRIX										
Ready										

Figure 2. Example of cross-reference framework

The intersection of columns and rows in each cell in the matrix thus corresponds to a single subgoal and a single policy initiative. When a law is relevant to a subgoal, the cell has a highlighted border and contains one or more bulleted items briefly summarizing or describing the information available about the relationship between the law and goal. Each cell containing such bullets has more detailed information in a *Cell Note* "behind" the cell. When the information matrix is used in its digital form, simply clicking on the cell produces a pop-up window that reveals the full text associated with the legislation. A full printout of the matrix and cell contents can be found in Hodge *et. al.* (1993a).

The detailed cross-tabulation of this legislative information has proved to be valuable for WSDOT staff and other transportation planners in Washington State interested in public transportation policy. The tabulation also proved to be an important resource for subsequent research tasks that required consideration of the specific elements of individual legislative acts. For example, in Case Study 3, which examined the implications of LOS and performance analysis associated with regional mobility and clean air concerns, the matrix was used to revisit the specific requirements of the applicable laws, including the list of approved transportation control measures identified in the Clean Air Act.

Initially, we envisioned that this framework of State Goals could also serve as a template for associating specific evaluation measures with each goal, subgoal, and objective developed in the state planning process. In the early phase of the project this was attempted (see Working Paper 1.3 Hodge *et al.* 1993c). Ultimately, however, because of a great deal of evolution in WSDOT's organization of goal statements and objectives, the research project was unable to fully support this correlation during the contract period. Alternatively, the project explored prototypical case studies (Hodge and Orrell 1994) in which various evaluation criteria applicable to certain generic goals were examined. In addition, the research examined the prototype assessment framework (Hodge and Orrell 1995) associated with the specific WSDOT category Personal

Mobility, which remained fairly stable over the course of the project and which was viewed as central to WSDOT's interest in public transportation evaluation.

A Catalogue of Evaluation Criteria

While each of the elements of the framework for public transportation provision and evaluation shown in Figure 1 provided a starting point for defining and interpreting evaluation criteria, this project also developed a number of specific subcategories that provided more clarity to the broader elements. Table 2 presents an overview of this detailed framework, in which the basic elements are listed in the first column, and the second column contains broad categories of performance measures associated with each of the basic elements. For example, under the element of **inputs**, a distinction is made between measures of financial inputs and measures of resource inputs. For each of these general categories, more specific categories of performance measures, such as cost measures, revenue measures, and fund balances, are displayed in the second column. The third column provides one of many examples of performance measures associated with each category of measures. A full description of each category and a detailed list of specific measures (including a cross-reference of Section 15 measures) is provided by Hodge *et al.* (1994a).

A major emphasis of this research was to recognize and implement a broader definition of public transportation than that traditionally used by identifying the role of public transportation within a **mix of transportation alternatives** pursued by communities. Recent legislation at the local, Washington state, and federal levels, as described above, places renewed emphasis on the potential of public transportation to help solve a variety of problems seen in the current form and effects of the transportation system. Given this broader understanding of the role of public transportation, different agencies will have community-specific goals and objectives for their public transportation systems; the institutional environments that produce the goals and objectives will vary, too. Therefore,

Table 2. General categories and examples of performance measures associated with the process of public transportation provision and evaluation

Elements of Public Transportation Provision and Evaluation	General Categories of Performance Measures	Example Performance Measures
Inputs		
<ul style="list-style-type: none"> •Financial Inputs •Resource Inputs 	<ul style="list-style-type: none"> •Cost Measures •Revenue Measures •Fund Balances •Labor •Equipment •Materials •Infrastructure 	<ul style="list-style-type: none"> •Total operating costs •Total revenue •Cost vs. revenue •Total employees •Capacity of system •Energy Consumed •Line miles
Activities Provided		
<ul style="list-style-type: none"> •Character of Activities Provided •Quantity of Activities Provided •Quality of Activities Provided •Input Efficiency (inputs per activity provided) 	<ul style="list-style-type: none"> •Descriptive Information •Activities Provided •Capacity Measures •Accessibility •Relative Activity •Safety Measures •Reliability •Accessibility •Cost Efficiency •Resource Efficiency 	<ul style="list-style-type: none"> •Service area population •Modal choices •Vehicle miles and hours •Miles/capita •Vehicle service hours/ service area pop. •Vehicle miles per accident •On-time performance •Relative travel time (vs. auto) •Operating cost/vehicle hours •Employees/vehicle mile
Response to Activities		
<ul style="list-style-type: none"> •Response •Activity Utilization •Input Effectiveness (response per input) 	<ul style="list-style-type: none"> •Absolute Measures •Measure of Utilization •Cost Effectiveness •Resource Effectiveness •Activity Effectiveness 	<ul style="list-style-type: none"> •Passengers •Vehicle miles traveled •Mode split •Passenger miles per capita •Costs per passenger trip •Passengers/vehicle •Passengers/service area pop.

Table 2. General categories and examples of performance measures associated with the process of public transportation provision and evaluation (continued)

Elements of Public Transportation Provision and Evaluation	General Categories of Performance Measures	Example Performance Measures
Outcomes		
<ul style="list-style-type: none"> •On Functioning of Transportation System •On Community •Outcome Effectiveness •Goal Attainment 	<ul style="list-style-type: none"> •Amount of Travel •Travel Time •Environmental Impacts •Economic Impacts •Population Mobility •Transportation System Related •Community Related •Transportation System Related •Community Related 	<ul style="list-style-type: none"> •Volume-to-capacity load factors •Relative travel time (auto vs.transit) •Fuel consumed/service area population •Number of jobs provided •Vehicle mile/service area population •Passenger trips/route mile •Fuel efficiency/route mile •Change in public transportation utilization •Impacts of added busline on air pollution

while the process of public transportation provision and evaluation (Figure 1) adequately describes the context of evaluation and provides a convenient framework for categorizing specific measures, we found that the actual implementation of these concepts differs from system to system and for different planning environments. The fact that different providers act on **different mandates** and in **different contexts** means that they place **different emphasis** on the elements of public transportation provision and evaluation. Because different elements of the process are emphasized, outcomes and impacts on the system and the community can also be expected to vary.

This finding also suggests that the use of different types of performance measures associated with one or more of the elements in the evaluation process may ultimately reflect a specific institutional, political, or social perspective towards public transportation, and when entities choose certain measures over others, public transportation provision and evaluation are directed towards certain results, **whether that is intended or not**. Thus, it is critical to explore the intent and implications of various performance measures as they are applied in any evaluation context. These issues are more fully explored and documented throughout the results of the case studies described below.

LOS Criteria

This section examines public transportation LOS indicators organized around each of the elements of transportation provision and evaluation identified previously. The product of this effort, summarized in Table 3, portrays how a wide range of definitions for LOS have been developed for different evaluation purposes and contexts. A full description and discussion of the examples provided in Table 3 can be found in Hodge and Orrell (1994). These results again demonstrate the variety of perspectives that have typically been invoked to define LOS criteria. Some perspectives stress the characterization of public transportation activities provided (e.g., frequency of service),

Table 3. Examples of LOS indicators categorized within the framework

Elements of Public Transportation Provision	Examples of LOS Indicators from Literature	Examples of Selected LOS Definitions in Washington State
Inputs (Financial and Resources)	Cost vs. revenue measures [Allen and DiCesare 1976] Per Capita Expenditures & Subsidies [Hodge 1981, MacGregor 1981]	PSRC percentage of investment in public transportation?
Activities Provided		
Public Transportation Related Policies and Programs		Almost all current approaches emphasize the inclusion of transit "supportive" policies and programs as part of LOS.
General Character of Activities, Providers and Context	Service Area and Service Population [Rutherford and Kelly 1983]	WSDOT is very concerned with facilitating a greater level of coordination among public transportation activities and providers. To accomplish this they are beginning to collect information about all public transportation activities and providers as part of their county profiles.
Quantity	Frequency [Alter 1976] Access Distance To Transit [Alter 1976] Access Time To Transit [Alter 1976] Route Spacing [Allen 1976] Stop Spacing Vehicle Hours or Miles [Traditionally collected by local, state and federal agencies] Geographic Accessibility (Miller 1977) Basic Connectivity Population Weighted Frequency of Accessibility	METRO, Pierce Transit METRO Pierce Transit WSDOT City of Renton, ODOT
Quality	On-time Performance [Alter 1976] Load Factors as Comfort [Bakker 1976] Customer Satisfaction Safety [Allen 1976] Security [Allen 1976] Quality of Accessibility Population Weighted Standard Travel Time [Miller 1977] Directness of Service [Alter 1976]	King County (optional) Peninsula RTPO WSDOT? WSDOT? City of Seattle (standard transit travel times on transit priority network)

Table 3. Examples of LOS indicators categorized within the framework (continued)

Elements of Public Transportation Provision	Examples of LOS Indicators from Literature	Examples of Selected LOS Definitions in Washington State
Response To Activities		
<p>Absolute</p> <p>Response Factored By Distance Traveled</p>	<p>non-SOV modes: Passengers</p> <p>non-SOV modes: Passenger Miles</p> <p>SOV's: Vehicle Miles Traveled (VMT) or Vehicle Hours Traveled (VHT)</p> <p>Combined Modes: Person Miles Traveled</p>	
<p>Relative Percentage of Transportation Activity Utilization</p>	<p>non-SOV modes: passengers per capita</p> <p>SOV's: VMT of VHT per capita</p> <p>Combined Modes: Mode-Split; Person Miles Per Capita</p>	<p>Mode-Split: TRPC, King County, METRO</p>
Outcomes of Activities		
<p>Functioning of Transportation System Components</p>	<p>Non-SOV Modes: Load Factors (Volume to Capacity)[Alter 1976], Travel Time</p> <p>SOV-Modes: Volume to Capacity Travel Time</p> <p>Combined Modes: Person Trip Volume To Capacity (City of Miami)</p> <p>Auto vs. Transit Travel Time [Alter 1976]</p>	<p>Metro?, Peninsula RTPO</p> <p>Pierce County, All traditional applications of LOS term.</p> <p>Relative Travel Time: King County (optional), PSRC?, City of Renton,</p>
Other Community Concerns	<p>Not commonly discussed as part of LOS in the literature or in local approaches to public transportation LOS.</p>	

some stress the response to the activities provided (e.g., ridership levels or mode split), whereas others stress the overall functioning of the transportation system (e.g., relative travel time and volume to capacity). These observations explain in part the confusion among planners as they attempt to develop a standard definition for LOS that would apply across application purposes and contexts.

Our observations about the development and application of LOS criteria also suggest that **a selected focus on any particular element in the evaluation process will likely result in incomplete evaluation conclusions.** The original development of LOS indicators for roadway segments and automobile travel tell this story very well. The traditional indicators have stressed the ease of movement by automobile; when congestion has been measured, the evaluation outcome has normally been to build a bigger road, even though better alternatives may exist. The traditional focus of LOS indicators in public transportation has been equally constrained. The traditional understanding of LOS as applied to public transportation has emphasized route density, access distance, and frequency of service. These indicators, taken alone, point toward one conclusion: provide a certain amount of public transportation everywhere without regard for actual travel needs or alternative policies that might achieve the same, or better, results for less cost. Alternatively, this analysis suggests that to broadly interpret the meaning and implications of the LOS concept, it is necessary to consider **all** of the dimensions of production, utilization, and outcomes associated with public transportation activities, as success in one area may not correspond to success in another area.

APPLICATION OF EVALUATION CRITERIA

The findings for the empirical portion of this project are summarized in this section. The full text for each separate case study is described in Hodge and Orrell (1994 and 1995) for those interested in the details of a particular investigation.

Case Studies

The first three case studies provide a diverse range of situations important for understanding the development and application of LOS definitions as part of comprehensive evaluation frameworks for public transportation, particularly at the state level. In large part, this project attempted to provide examples that would reflect the range of possible state interest in public transportation evaluation and to reveal how the multiple interests of the state necessitates an approach to LOS and evaluation that is flexible and adaptable to different purposes.

The first case study, which focused on the development of a new service in a rural area of the Olympic Peninsula, was concerned with understanding the overall process of evaluation and how specific evaluation criteria were used in such a context. The development and evaluation of the proposed service presented a representative case for what the WSDOT Rail and Public Transportation Office sees as its primary mission: to ensure that all citizens of the state have some basic level of mobility and accessibility, both within communities and between regional centers. This study highlighted how assumptions about the provision of service, funding, and equity all affect the interpretation of LOS and the various evaluation conclusions that can be reached, depending upon initial assumptions and the perspective taken in the evaluation process.

The second case study examined the development of LOS definitions under the current planning efforts of growth management. The results from this analysis revealed a significant disjuncture between the intents of growth management reflected in the concurrency concept, community planning goals, and actual LOS definitions in three King County cities. The reasons for this disjuncture were attributed primarily to the institutional arrangements governing public transportation funding and provision at the county-wide level. The conclusions from this study thus emphasized that WSDOT should take an active leadership role in helping communities, and legislators, embrace

both a more comprehensive approach to LOS definitions under growth management and a critical evaluation of current public transportation institutional barriers.

The third case study presented an example of the multi-modal, and multi-policy LOS evaluation demands associated with ISTEA and the Clean Air Act. This investigation revealed the expanded emphasis for LOS under these mandates on outcomes, outcome effectiveness, and alternative analysis. An examination of the proposed commuter rail services in the North Corridor from this perspective provided insight into the state interest in evaluating projects with multi-modal congestion and air quality implications. The existing state perspective of evaluation for this service, which provided the initial frame of reference for studying its feasibility, was shown to be limited to one dimension of evaluation (i.e., cost effectiveness) based on one performance measure (i.e., cost per passenger mile), which obscured the level of outcome-based evaluation expected under recent congestion management and air quality legislative mandates. In contrast, this example highlighted how a multi-modal, multi-policy LOS evaluation of public transportation activities centers more on the interpretation of relative outcomes and relative goal attainment associated with policy and program options, than it does on fixed-route frequency of service.

In general, the first three case studies were undertaken to demonstrate how an improved understanding of transportation evaluation is contingent upon understanding the measures that are used, and emphasized, in different types of evaluation contexts. Each of these examples showed that certain key elements of evaluation are typically stressed in different types of evaluation applications and that, in each case, current practices could be improved through distinct state roles in these processes.

The fourth case study documented an approach to define Washington State's interest in basic access criteria and standards for its citizens. The criteria and standards proposed in this case study were developed for two purposes. First, they were to provide a starting point for defining a minimum ability of all citizens in the state to travel, both

within and between communities, when a private means of transportation is unavailable to them. Second, the selected criteria and proposed standards were intended to provide a measurement tool to assess the extent to which communities, regions, and the state are achieving their mobility goals (see Table 4). In other words, this framework was developed to estimate the proportion of a community's, or county's, population that currently has access to basic mobility services as defined by the selected criteria: choice, availability, inter-city connections, and affordability. Two levels of standards (minimum and preferred) were identified for use in evaluating the status of basic mobility in Washington State along the four criteria dimensions (Table 4).

This study applied geographic information system (GIS) techniques, census data, and transit service information to estimate the percentage of population with mobility options as defined by the four sets of criteria and the different standard levels. The full results of the application of this standards framework to Jefferson County are described in Hodge and Orrell (1995). A graphic example highlighting the application of GIS to the problem is shown in Figure 3.

Although this application demonstrated the relative ease by which the selected criteria could be evaluated using common GIS techniques and data, it also revealed that this type of analysis inevitably points to the need for addressing other evaluation questions. That is, once it has been determined that a certain percentage of the population currently has a mobility option, what criteria and standards should apply in the decision-making processes to determine how, or if, the remaining unserved populations are provided new or additional service? These questions ultimately must be addressed, and the results from the other case studies, particularly the first case study, suggest that different participants in the evaluation process will likely bring different perspectives and expectations to the process. This is where the framework developed in this research can help, by providing a common ground upon which to facilitate the additional aspects of the evaluation process.

Table 4. Minimum and Preferred Mobility Standards

Criteria	Mobility Issue Addressed	Minimum Mobility Standards		Preferred Mobility Standards	
		Fixed-Route	Paratransit	Fixed-Route	Paratransit
Choice	Do citizens have a choice for mobility if a private vehicle is not available? Are there eligibility restrictions that limit citizen mobility?	Citizen within <u>3/4</u> mile of a route.	Citizen with unrestricted dial-a-ride alternative.	Citizen within <u>1/4</u> mile of a route.	Citizen with unrestricted dial-a-ride alternative.
	Are the mobility choices available weekdays only or everyday? What hours of the day are the services available? How often are services potentially available? Are there trip purpose, reservation, or departure time restrictions that limit mobility?	5 days per week 8am-6:00pm Minimum of <u>two</u> bi-directional trips available per day.	5 days per week 8am-6:00pm Minimum of <u>one</u> round trip available per day. Maximum <u>24</u> hour advance reservation for travel within <u>4</u> hours of desired departure time.	7 days per week 7am-11:00pm <u>Hourly</u> bi-directional travel available.	7 days per week 7am-11:00pm Minimum of <u>two</u> or more round trips available per day. Maximum <u>12</u> hour advance reservation for travel within <u>2</u> hours of desired departure time.
Inter-City Connections	Do citizens have a mobility option to other communities?	Connections with inter-city services.	Connections with inter-city services.	Connections with inter-city services.	Connections with inter-city services.
	Can citizens take advantage of services at a reasonable cost?	Fares less than or equal to 150% of state-wide average fare. Volunteer Services or Transportation Vouchers Available	Fares less than or equal to 150% of state-wide average fare. Volunteer Services or Transportation Vouchers Available	Fares less than or equal to 150% of state-wide average fare. Volunteer Services or Transportation Vouchers Available	Fares less than or equal to 150% of state-wide average fare. Volunteer Services or Transportation Vouchers Available
Affordability					

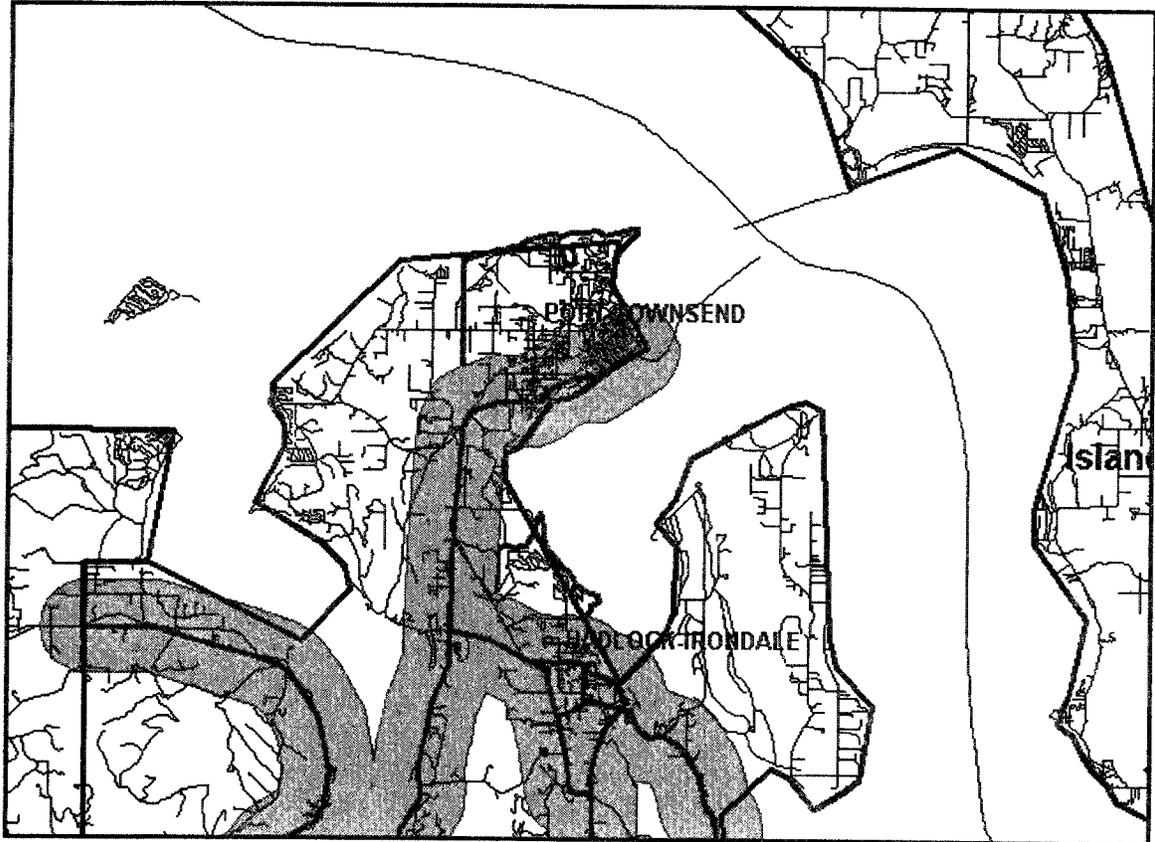


Figure 3. Access levels defined through GIS

Performance Profiles and Context

Our analysis revealed that there are eight underlying dimensions to the relative performance measures, including *intensity of systems use, operating resource efficiency, operating expense efficiency, intensity of vehicle use, operating expense effectiveness, employee efficiency and effectiveness, operator efficiency, and fuel and maintenance efficiency*. By examining performance according to these eight dimensions, we were able to create groups of systems that behaved similarly with respect to all the dimensions of performance measures considered simultaneously. What this analysis revealed is that efficiency, conceptualized in several different ways, plays an important role in differentiating between systems. Operating resource efficiency, operator efficiency, and fuel and maintenance efficiency strongly differed between clusters. It is impossible for systems to score well on all variables—these clusters showed that systems can be meaningfully grouped according to their full profile of performance measures.

The analysis of the context variables revealed nine underlying dimensions that characterize context: *transportation status, personal services, demographics, African American population, blue collar employment, employment structure, and “urban-ness.”* These factors were used to create seven distinct clusters of counties. Transportation status, African American population, blue collar employment, and demographics proved to be the most important characteristics defining these groups.

The relationship between performance measures and context was explored in a variety of ways. A comparison of performance factor scores across context clusters revealed only weak differences between contexts. Similarly, a comparison of context factor scores across performance measure clusters revealed only weak differences in context profiles between groups. Regression analyses produced modest but respectable results, with the best r-squared values in the .50 range. This result indicated that a meaningful amount of the variation in performance across systems can be accounted for

by context. In general, larger metropolitan systems cost relatively more to operate (largely because of higher wages), but they are also more effective in their use of resources (largely because of higher densities and a more transit dependent population).

Our analysis of context also examined Beale Code classes and jurisdictional context. Beale Codes proved to be very weakly related to performance measures, while jurisdictional arrangements (as classified here) did not seem to present a basis for differentiating performance. This is not to say that political and administrative arrangements do not matter in how service is supplied and performs, but they do not explain the differences that occur in performance between systems.

CONCLUSIONS

Despite the breadth of issues and examples covered in this research, several clear themes related to public transportation evaluation stand out as significant conclusions. First, and most importantly, we found that because multiple goals and expectations motivate the provision of public transportation services and policies, these goals, and their inter-relationships, must be explicitly identified in each evaluation context. The importance of this goal-awareness process is critical because the diverse expectations of public transportation will often result in conflicting or contradictory evaluation foci as a result of multiple goals. This characteristic of public transportation evaluation is exacerbated by the fact that various political, social, and institutional perspectives invariably held by different parties to the evaluation process will often result in the application of only limited criteria.

These aspects of the use of evaluation criteria point to a second major conclusion from this research: that no single evaluation indicator should be used to evaluate any system, service, or potential policy. Each of the case studies clearly showed that although evaluation processes may logically begin with one dominant dimension of evaluation, invariably it is necessary to incorporate many other evaluation dimensions to support the decision-making process. Unfortunately, current evaluation practices and the complexity of issues involved seem to have resulted in exactly the opposite. In other words, most of the evaluation frameworks, processes, and standards examined in this research were based on singular criteria. Furthermore, in some cases, such as the growth management example in Washington State, the singular criteria adopted were themselves often distorted and indirectly related to the phenomena they were supposed to measure. The reasons for this problem reflect the fact that various political and institutional factors directly structure the types of criteria that are developed, applied, and even considered in evaluation processes.

Finally, we found that context matters, but not quite in the simple way we had expected. There are obviously a variety of methods by which to explore the relevance and meaning of context for public transportation. We attempted to characterize context in several ways, using a variety of approaches to explain variation in public transportation performance measures. Although some of the performance measures can be modestly explained by context variables, most are at best weakly explained. Doubtless part of this somewhat surprising level of explanation is due to the data and methods we used. These methods sought broad patterns of generalities and, in so doing, captured only a portion of the complex variation in performance between systems. This lack of systematic variation, at least using the measures we had available, also suggest that there are many unique combinations of factors, including, most likely, organizational, structural, philosophical, and historical, that account for differences in performance between transit systems. In other words, there is a great deal of local autonomy beyond context in determining the performance of a transit system, including decisions about which aspect of service to emphasize, as well as about how to deliver that service.

RECOMMENDATIONS AND APPLICATION

This research points to the three broad recommendations regarding Washington state's role in public transportation evaluation. First, in general, local authorities and communities are in the best position to take the lead in selecting and implementing evaluation criteria and standards. The primary state role, and the role that has traditionally guided WSDOT interaction with local transit providers, should be **to facilitate evaluation processes** where basic state interest is involved or where various community groups need assistance in reaching common ground in the evaluation process. WSDOT can utilize the framework developed and applied throughout this project to facilitate these activities. Above all, WSDOT should encourage the explicit expression of system goals and the use of multiple performance measures that properly evaluate progress towards those goals.

Second, where specific groups or contexts require a quantification of various aspects of performance in order to better appreciate how some service compares to other services of this type, **WSDOT can use the results from the statistical analyses in Working Paper 1.6 as relevant background material** for these purposes.

Finally, we recommend that **WSDOT continue to take the lead in establishing minimum standards of access for all citizens** of Washington following the logic of the prototype developed in this project. Additional effort is needed to better define the exact criteria to be used and to differentiate the criteria by context. This should be considered as a special case associated with attempts to determine appropriate levels of service. However, it avoids some of the most difficult, and so far unresolvable, problems with more widespread development of public transportation level of service standards.

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