CHAPTER 4—SELECTING MOBILITY MEASURES

Chapter Summary

The appropriate set of mobility measures will include several identifiable elements. This chapter identifies the important features as:

- Relate to goals and objectives,
- clearly communicate results to audiences,
- include urban travel modes,
- have consistency and accuracy,
- illustrate the effect of improvements,
- be applicable to existing and future conditions,
- be applicable at several geographic levels,
- use person- and goods-movement terms, and
- use cost-effective methods to collect and/or estimate data.

This chapter also identifies the four aspects of congestion to identify mobility levels. Information about the time, location, level, and reliability are needed to assess mobility for the range of analyses.

Given the wide range and diversity of available measures, it is important to have a clear basis for assessing and comparing mobility measures. Such an evaluation makes it possible to identify and separate measures that are useful for an analytical task from measures that are either less useful or inappropriate for certain analyses. It is important that every use of mobility measures be assessed in such a process. This chapter provides several considerations that can be used to identify the most appropriate mobility measure for a situation.

4.1 Choosing the Right Mobility Measure

The ideal mobility measurement technique for any combination of uses and audiences will include the features listed below (*1*). These issues should be examined before data are collected and the analysis begins, but after the analyst has considered all reasonable responses to the problem or issue being studied. Having an idea of what the possible solutions are will produce a more appropriate set of measures.

- **Relate to goals and objectives**—The measures must indicate progress toward transportation and land use goals that the project or program attempts to satisfy. Measuring transportation and land use characteristics that are part of the desired future condition will provide a continual check on whether the area is moving toward the desired condition.

- **Clearly communicate results to audiences**—While the technical calculation of mobility information may require complicated computer models or estimation techniques, the resulting information should be in terms the audience can understand and find relevant.

- **Include urban travel modes**—Mobility is often a function of more than one travel mode or system. At least some of the measures should contain information that can be calculated for each element of the transportation system. The ability to analyze the system, as well as individual elements, is useful in the selection of alternatives.

- **Have consistency and accuracy**—Similar levels of mobility, as perceived by travelers, should have similar mobility measures. This is important for analytical precision and also to maintain the perception of relevancy with the audiences. There should also be consistency between levels of analysis detail; results from relatively simple procedures should be similar to those obtained from complex models. One method for ensuring this is to use default factors for unknown data items. Another method is to frequently check expected results with field conditions after an improvement to ensure that simple procedures—those that use one to three input factors—produce reasonable values.

- **Illustrate the effect of improvements**—The improvements that may be analyzed should be consistent with the measures that are used. In relatively small areas of analysis, smaller urbanized areas, or portions of urban areas without modal options, this may mean that vehicle-based performance measures are useful. Using a broader set of measures will, however, ensure that the analysis is transferable to other uses.

- **Be applicable to existing and future conditions**—Examining the need for improvements to current operations is a typical use of mobility measures that can be satisfied with data collection and analysis techniques. The ability to relate future conditions (e.g., design elements, demand level, and operating systems) to mobility levels is also required in most analyses.

- **Be applicable at several geographic levels**—A set of mobility measures should include statistics that can illustrate conditions for a range of situations, from individual travelers or locations to subregional and regional levels. Using quantities that can be aggregated and averaged is an important element of these criteria.

- **Use person- and goods-movement terms**—A set of measures should include factors with units relating to the movement of people and freight. In the simplest terms, this means using units such as persons and tons. More complex assessments of benefits will examine the different travel patterns of personal travel, freight shipping, and the intermodal connections for each.

- **Use cost-effective methods to collect and/or estimate data**—Using readily available data or data collected for other purposes is a method of maximizing the usefulness of any data collection activities. Focusing direct data collection on

significant problem areas may also be a tactic to make efficient use of data collection funding. Models and data sampling procedures can also be used very effectively.

4.2 The Ideal Mobility Measurement Process?

The best method to gather mobility information and user satisfaction data may be a survey conducted at the end of each trip. The survey would allow the traveler to rate the quality of the trip, both overall and for each facility or modal portion of the trip. Cost, time, and travel options could all be part of the survey. This would provide the transportation and land use professionals with a database they could match to system monitoring databases to identify potential causes of good and bad responses during the trip.

Freight shippers and manufacturers could be similarly surveyed about their use of the transportation system and its effect on their operations. These impacts may be more varied and require different surveying mechanisms. Processes such as just-in-time manufacturing and package delivery services have much different needs from the transportation system than some traditional activities. Just-in-time manufacturing is a method of delivering components to an assembly point at the moment they are required rather than having a large inventory of parts on hand at the factory. This has benefits in reduced warehouse space, reduced financial burden of inventory, and other efficiency impacts. This process, as it is with package delivery services, places great reliance on the transportation system to provide a reliable travel time. Longer travel times are an important issue, but the assembly process can be adjusted to accommodate them; it is more difficult or less efficient to accommodate variable travel times.

While surveys are certainly technologically possible now, and some are conducted, the amount of time needed to complete the survey could be longer than hurried travelers wish to take. If the method of obtaining the input and the time it would take could both be problems, does that make opinion gathering a bad idea? Not at all; the public—private citizens and businesses—pay for the transportation system and are the ultimate decision makers about the worth of a project.

One significant problem, however, is that transport facilities exist in segments or corridors (even telecommunications move in corridors of cable or airwaves) and person trips (and electronic trips to some extent) are made from an origin to a destination. This requires measuring the performance of specific facilities or groups of facilities, in addition to the trip characteristics.

Focusing on individual facilities or modes, however, is not consistent with the manner in which most travelers make their choices. Door-to-door travel time is closer to the primary measure used by travelers and is best described with accessibility measures. Unfortunately, it is difficult to translate an accessibility measure like “population within 30 minutes travel time of a major activity center” into a procedure to evaluate signal improvements on an arterial street or alternative transit service options in a corridor. Accessibility measures do a very good job of explaining the differences in opportunities available to residents and travelers in areas of a city. The transportation and land use planning model required to calculate accessibility measures may not be sensitive enough to identify the improvement in travel conditions from relatively modest

improvements. The planner and designer, likewise, need to communicate with the public and businesses who, while they are interested in the jobs and customers that may be within easy traveling distance, also wish to know how the travel time to their destinations will change.

4.3 The Data Collection Issue

Concerns about the cost and feasibility of collecting travel time data are frequently the first issue mentioned in discussions of mobility measures. There are many ways to collect or estimate the travel time and speed quantities; data collection should not be the determining factor about which measures are used. While it is not always possible to separate data collection issues from measure selection, this should be the goal. Chapters 5 and 7 discuss data collection in more detail.

4.4 Aspects of Mobility

The proper set of mobility measures includes an assessment of what traveler concerns are characterized. This assessment can be drawn from experiences with measuring congestion in roadway systems. A set of four aspects of congestion was discussed at the Workshop on Urban Congestion Monitoring (*2*) in May 1990 as a way to begin formulating an overall congestion index. These four components provide a useful framework for mobility estimation procedures as well.

Summarizing Congestion Effects Using Four General Components

While it is difficult to conceive of a single value that will describe all of the travelers' concerns about congestion, there are four components that interact in a congested roadway or system (*2*). These components are duration, extent, intensity, and variation. They vary among and within urban areas. Smaller urban areas, for example, usually have shorter duration, than larger areas, but many have locations with relatively intense congestion.

The four components and measurement concepts that can be used to quantify them are discussed below. They use the definitions of congestion and mobility used in this paper. The data elements and measures associated with each concept are discussed in Chapter 5.

- **Duration**—This is defined as the length of time during which congestion affects the travel system. The peak hour has expanded to a peak period in many corridors, and mobility studies have expanded accordingly. The measurement concept that illustrates duration is the amount of time during the day that the travel speed indicates congested travel on a system element or the entire system. The travel speed might be obtained in several ways depending on data sources or travel mode being studied.

- **Extent**—This is described by estimating the number of people or vehicles affected by congestion and by the geographic distribution of congestion. The person congestion extent may be measured by person-miles of travel or person-trips that occur during congested periods. The percent, route-miles, or lane-miles of the transportation

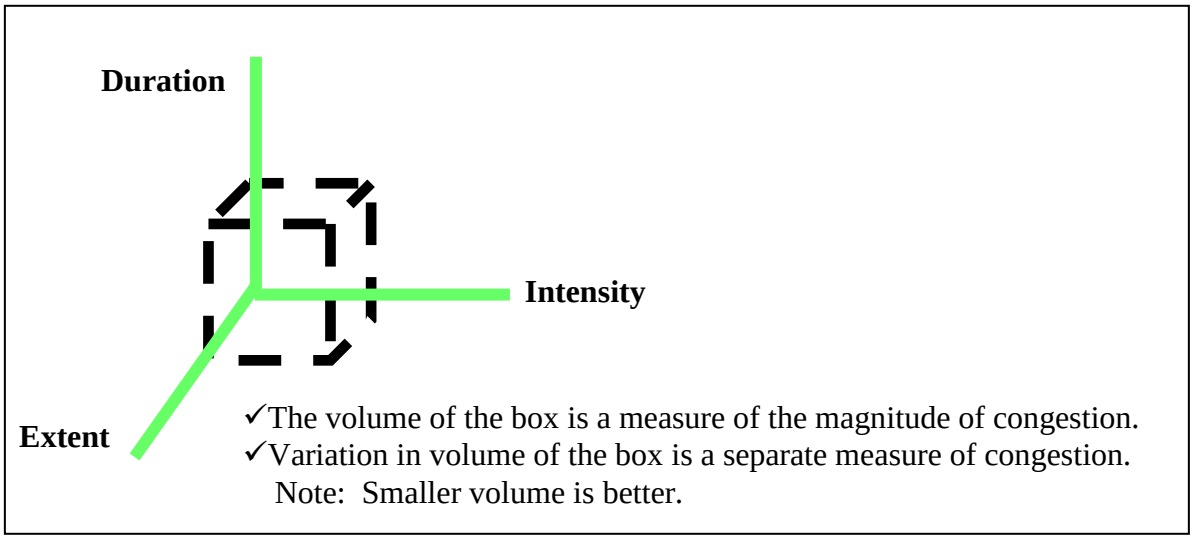
system affected by congestion may be used to measure the geographic extent of mobility problems.

- **Intensity**—The severity of congestion that affects travel is a measure from an individual traveler's perspective. In concept, it is measured as the difference between the desired condition and the conditions being analyzed.

- **Variation**—This key mobility component describes the change in the other three elements. Recurring delay (the regular, daily delay that occurs due to high traffic volumes) is relatively stable. Delay that occurs due to congestion and vehicle breakdowns, however, is less easy to predict. The variation in travel time is a factor that conceptually can be measured as a standard deviation from the average travel time.

The relationship among the four components may be thought of as a three-dimensional box describing the magnitude of congestion. Exhibit 4-1 illustrates three dimensions—duration, extent and intensity—of congestion. These present information about three separate issues: 1) how long the system is congested, 2) how much of the system is affected, and 3) how bad the congestion problem is. The variation in the size of the box from day to day is a measure of variability or reliability.

Exhibit 4-1. The Components of Congestion.



4.5 Summarizing the Aspects of Mobility

Developing a summary of mobility using concepts similar to those used for congestion will ensure that the appropriate measures are used. A similar typology uses different terms; there is a "positive" tone in the phrasing of the definitions and a slightly different orientation from congestion, but the aspects are basically the same. The image of a box is also appropriate to the description of the amount of mobility provided by a transportation and land use system. The axes are time, location, and level. Reliability is now the change in box volume.

- **Time**—The time that mobility is provided or available is an expression of the variation of mobility through the day, week, or year. It can be a function of the existence of congestion or the presence of transit service, operational improvements, or priority treatments. It can be measured as the times when travelers can get to their destinations in satisfactory travel times.

- **Location**—The places or trips for which mobility is available is an important aspect of measurement for transportation and land use analyses, as well as for other issues such as economic development and social equity. It can be described by accessibility maps and statistics and travel time contours that illustrate the areas that can be traveled to in a certain period of time. Descriptions of transit routes or special transportation services can also be used to identify locations where mobility is possible by more than private auto modes.

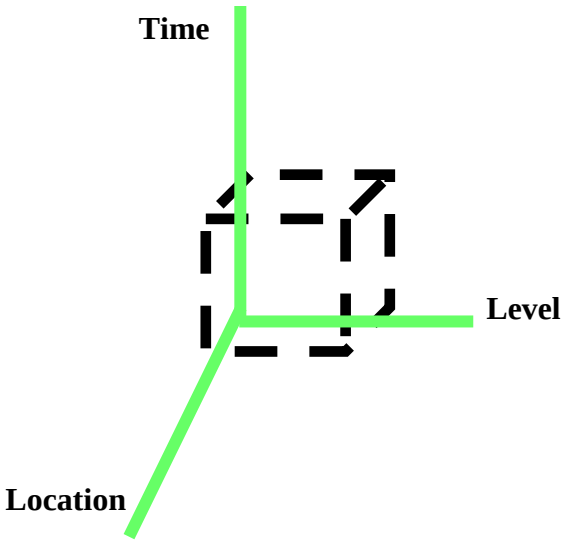
- **Level**—The amount of mobility provided is analogous to the intensity of congestion. The amount of time it takes to travel to a destination and whether this is satisfactory are the key elements of the level of mobility. It can be measured with travel rates or accessibility statistics.

- **Reliability**—The changing times, locations, and levels of mobility are important characteristics for mobility measurement. This is particularly important to freight movement operations that rely on the transportation system as an element of their productivity and to measuring the frustration level of travelers faced with an unexpected loss of mobility.

The total amount of mobility provided to travelers in an area is the volume of a box with axes of time, location, and level. The reliability of the mobility provided to travelers and residents is the change in the volume of the box from time period to time period or from day to day. Exhibit 4-2 illustrates the description of mobility with the four aspects. These answer the key questions of travelers and residents: 1) When can I travel in a satisfactory amount of time? 2) Where can I travel in a satisfactory amount of time? 3) How much time will it take? 4) How much will my travel time vary from trip to trip?

Answering the key questions with measures of the four components of mobility will encompass the needs of residents and travelers as well as transportation and land use professionals.

Exhibit 4-2. The Components of Mobility.



✓The volume of the box is the amount of mobility provided.
✓A change in volume of the box indicates the reliability of the mobility system.
Note: Larger volume is better.

4.6 References

1. *NCHRP Report 398*. Quantifying Congestion—Final Report and User's Guide. National Cooperative Highway Research Program Project 7-13, National Research Council, 1997.

2. *Summary and Recommendations of the Workshop on National Urban Congestion Monitoring*. U.S. Department of Transportation, Federal Highway Administration, Office of Highway Information Management, Report No. FHWA-PL-90-029, September 1990.