



# Estimation Method for Interurban Accessibility: A Highway Performance Measure Indicating Smooth and Safe Traffic Flow

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## Abstract

Interurban accessibility is proposed as a new driver-oriented highway performance measure that indicates ease of access to a destination on interurban expressways connecting hub cities. This study develops a method for estimating the proposed measure based on a driver-utility approach. Through a numerical example, how to determine the planning level of the proposed measure is demonstrated in comparison with a required level of quality of traffic service.

*Keywords:* Quality of traffic service, Interurban accessibility, Utility-based evaluation, Driver perception

## 1 Introduction

Developing driver-oriented highway performance measures is the key to performance-based highway design. Highways should be designed so that an appropriate performance measure corresponding to major highway functions can achieve a required level of quality of traffic service. Quantitative assessments of performance measures need to evaluate the achieved level of performance as compared with the required level. Various measures have been proposed, such as overall travel speed, target travel speed, travel time, traffic safety, traffic density, congestion, freedom to maneuver, and driving comfort and convenience (HRB, 1965; TRB, 1985; FGSV, 1988). However, it is unclear how existing performance measures relate to driver perceptions of the quality of traffic service.

This study focuses on ease of access to destinations as a new driver-oriented performance measure under various driving conditions on interurban expressways connecting hub cities. This measure indicates the ease of maintaining vehicle speed near a target travel speed while maintaining a constant headway in the lane. We hereinafter refer to this measure as “interurban accessibility.” Interurban

accessibility can be expressed as the sum total of utility that each driver perceives from smooth and safe traffic flow at each point in interurban expressway lanes.

The objectives of this study are twofold. One objective is to develop an estimation method for interurban accessibility based on driver utility as proposed by Kita et al. (2014). Their experimental results indicate that our proposed measure more appropriately describes driver perceptions of the quality of traffic service than do previously proposed performance measures. The other objective is to demonstrate how to use interurban accessibility to determine the planning level of the performance measure in comparison with a required level of quality of traffic service.

## 2 Literature Review

Identifying the quality of traffic service perceived by drivers has been of great concern in previous studies. Kita (2000) showed that when estimating driver perception from driving behavior with utility maximization, driving utility as perceived by the drivers was an effective measure of quality of traffic service. Nakamura et al. (2000) showed that traffic flow rate, number of lane changes, and elapsed time of car-following most strongly affected the degree of satisfaction that drivers perceived. From focus groups, Hall et al. (2001) showed that travel time, traffic density and maneuverability, road safety, and traveler information had the greatest effect on the quality of traffic service. From video experiments, Choocharukul et al. (2004) found that traffic density was a suitable simple performance measure from among various measures. Using in-field surveys, Washburn et al. (2004) showed that traffic density appeared to be a primary factor in driver-perceived quality of traffic service, though the drivers considered three or more factors to be important. In the present study, method is developed for estimating interurban accessibility according to the utility-based evaluation approach (Kita, 2000) mentioned above.

## 3 Model of Highway Performance Measure

### 3.1 Prerequisites

Interurban-highway performance measures should adequately assess the smoothness and safety of traffic flow. At a minimum, interurban accessibility must adequately consider the following:

1. Actual travel times as compared to target travel times
2. Driving safety
3. Differences in travel distance

### 3.2 Modeling the interurban accessibility measure

In modeling the interurban accessibility measure, the level of interurban accessibility decreases as travel time between hub cities increases or as freedom to maneuver decreases because of congestion and delays. Hence, our model of interurban accessibility assumes a target travel time, defined as the travel distance divided by the target travel speed, so interurban accessibility is presumed to increase with travel speed. In addition, Kita and Kouchi (2011a) showed that perception structures of interurban accessibility are momentarily formed by accumulating perceived values. Hence, our model involves both average and minimum point-based utilities in microscopic driving environments, so that accident risks contingent on speed can be considered for each point-based utility. Moreover, accumulation of point-based utilities between hub cities is considered to exert a decisive influence on the level of interurban accessibility. Driver memory is assumed to decay over elapsed driving time.

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